4. When viewed from a nearby property or a public location, the Proposal and associated infrastructure would be of a scale appropriate to the setting.
5. The Proposal would be of materials and forms that are sympathetic to the surrounds.

Once each of the views to the Proposal has been assessed against these 'desirable outcomes', an overall assessment of the potential visual impact would be made. The potential visual impact would be based on a rating of low, medium or high.

Proposed Mitigation Measures

The potential visual impacts for each of the views assessed would be collated and measures would then be made to mitigate identified impacts on affected properties and public locations

16.2 Existing Environment

16.2.1 Study Area

The northern watershed of the Nambucca River valley occurs along a ridgeline just 250 m northeast of the proposed storage. This ridgeline is approximately 100 m AHD behind the storage site, and rises towards the north to 466 m at Mount Viewmont. The area between the storage and the Nambucca River is low lying with average elevations of 10 – 20 m AHD. The storage area consists of lower elevations along Bowra Creek, which range from 20 to 60 metres (m) AHD and include numerous moderately steep gullies.

The proposed access road would use an already formed and gravelled road (Bobo Road) to the east of Bowra Creek and the inundation area. Bobo Road follows the forested crest of a ridgeline that marks the southern catchment for the proposed storage and extends eastward from the main Bowra Creek watershed. Below the ridgeline Bobo Road links with Valla Road and traverses cleared spurline crests to its intersection with Rodeo Drive.

The Nambucca River is characterised by a moderately sinuous channel planform with an approximate slope of 0.002 m/m. The channel flows through a valley approximately 200 to 300 metres wide. This wider valley setting means floodplains are often present on both sides of the channel. The channel through this reach is approximately 30 to 50 metres wide on straight sections and 50 to 80 metres wide on bend apexes.

16.2.2 Landscape Character

The following landscape character was assessed by describing the components of the existing landscape in detail such as its topography, land use, vegetation, water form, settlement patterns and other features

Within the identified view shed there are two landscape character types, which are:

- Rural; and
- Rural Town.

Rural

The landscape surrounding the Proposal is dominated by a rural valley landscape, which is defined by an undulating terrain utilised for grazing and limited crops as well as heavily forested

areas. The ridgelines are sometimes cleared and sometimes covered in vegetation. The vegetation is very tall and is characterised quite distinctly by the naturalness of the landform.

The local visual catchment has restricted accessibility because of the private freehold ownership of most of the land in the immediate area, the steep undulating landscape making road access difficult.

Figure 16-1 Example of Landscape Character (Rural) - Looking south west from storage embankment

Rural Town

Bowraville is located approximately 2 kilometres from the storage embankment . The town comprises predominantly single and double storey dwellings and commercial buildings surrounding by vegetation. The town has been established on undulating land with a ridgeline located to the south of the town centre.

16.3 Impact Assessment

16.3.1 Determining Affected Properties - View Sheds

The storage embankment would be a significant structure within the local landform vista and has the potential to change the existing local visual character.

To define the visual catchment, the extent of visibility of the storage embankment has been assessed using the viewshed analysis. The visual baseline included twenty points along the top of the storage embankment. The view shed analysis takes into account local screening from existing vegetation and the surrounding topography (as explained in section 16.1). Features such as built structures are not considered in the view-shed calculation. The view shed considered the existing vegetation south of the embankment, which was estimated at 20 metre high trees.

The distance between the observer and target object can affect the level of visual impact. The further the distance, the less space the target occupies in the observer's field of view and therefore the visual impact is not as significant.

The view shed for the landscape is extended to a distance at which the storage embankment is considered visually insignificant. The extent of the view shed and the ranges of visual impact are derived from Table 16-1. This table also describes the levels of visual impact within the view shed that would be used to assess the visual impact of the storage embankment.

The distance ranges described below are used as a guide to determine zones of visual impact. For example, visibility does not dramatically change when a viewer moves from 1.5 km to 1.6 km from the storage embankment, even though these locations are discussed in different bands that, for the purposes of analysis, show differing levels of impact. A photomontage of the storage within the surrounding environment is shown in Figure 16-2.

Table 16-1 View shed and zones of visual influence assumptions

Distance from an observer to the storage embankment	Zones of visual influence
>2 km	*Visually insignificant* A very small element in the view shed, which is difficult to discern and would be invisible in some lighting or weather circumstances.
1.6 km – 2 km	*Potentially noticeable, but would not dominate the landscape.* The degree of visual intrusion would depend on landscape and viewer sensitivity; the storage embankment would not dominate the landscape from this distance.
1.0 km – 1.5 km	*Potentially noticeable and can dominate the landscape.* The degree of visual intrusion would depend on the landscape sensitivity and the sensitivity of the viewer.
500 – 1.0 km	*Highly visible and would usually dominate the landscape* The degree of visual intrusion would depend on factors such as foreground screening.
0- 500 metres	*Would always be visually dominant in the landscape.* Dominates the landscape in which they are sited.

Figure 16-2 Aerial View of Proposal

In addition to the view shed analysis for the storage embankment, consideration has also been given to the potential impacts as a result of the proposed access roads, borefields and associated transformers.

16.3.2 Impact Assessment from Key Vantage Points

The view-shed analysis identified any properties or public locations likely to have views affected by the storage embankment. A site analysis was also undertaken for properties as having views potentially affected by the storage embankment would be utilised to illustrate the potential impacts. The selected viewpoints in this visual assessment provide a sufficient coverage of the surrounding views into or toward the storage embankment. This coverage of viewpoints is intended to give a comprehensive sense of the proposed positioning of the storage embankment site in its setting.

This assessment therefore looks at the potential visual impact from the following publicly accessible and private residences. It describes views to the site and to the storage embankment from key vantage points (including views showing existing nearby dwellings and views from major roads) sufficient to give a sense of the overall site in its setting.

Construction Phase

Proposed Storage

Views to the proposed storage are likely to take in machinery movement and operations, earthworks, mechanical installation, storage embankment works, road works and construction of the associated infrastructure. In many instances, views would be screened by on and off site vegetation.

Bobo Road would be upgraded to accommodate the heavy vehicle traffic required during construction. The increased truck movements would be a visual intrusion at a local level into a natural rural landscape vista however, the impact would be temporary. The sealing of the road and surrounding vegetation would mean less dust on the landscape and vegetation.

The works would involve earth material being excavated/ stockpiled within the storage site. Due to the height of the existing vegetation, material stockpiles are unlikely to cause any visual impact.

Following the completion of the construction phase of the Proposal, it would be likely the affected property would see an exposed earth embankment. Eventually these areas would be revegetated with grass or covered with rock (subject to detailed design). There would be no long-term visual impacts with the construction phase of the storage embankment.

Clearance of vegetation, including harvesting of economically viable timbers, would occur shortly before the storage is commenced. Whilst freshly cleared land would not be an attractive view, the activities would be in isolated locations and of temporary duration so would not cause significant long-term visual impact.

Proposed Access Roads, Borefields and associated Transformers

To link the borefields with the headworks and the storage transfer pipeline, a borefield collection pipeline would be constructed. This would involve excavation of a trench within the alluvial soils adjacent to the Nambucca River to average depths of approximately 3 m below ground level. It is expected that the excavation of soils could be undertaken using conventional earthmoving equipment and / or trench excavating equipment. Excavated soils would likely be temporarily stockpiled and reused for backfilling and landscaping of the pipeline trench to pre-existing ground levels. The backfilled trench would be immediately stabilised, rehabilitated and revegetated.

The existing local area power supply would be extended to provide power to the bore pumps. The arrangement of the extended power supply would involve:

- Placement of one additional transformer/ switchboard and telemetry north of the Nambucca River on Lot 2 DP 1073580 to supply power to the proposed bores;
- Placement of one additional transformer/ switchboard and telemetry south of the Nambucca River on Lot 463 DP 710439 to supply power to the proposed bores; and
- Placement of two additional transformer/ switchboard and telemetry to supply power to the proposed bores along South Arm on Lots 2 and 3 DP 612962.

The transformer / switchboard and telemetry would be placed on poles approximately 10m high and connected to the existing power grid via overhead lines. A typical transformer/switchboard is shown in Figure 16-3.

Figure 16-3 Typical transformer/ switchboard arrangement

Underground cabling would link the transformers to the each of the individual bore pumps. Cables would be at a minimum depth of 500 mm. This would involve excavation of trenches of up to 1 metre wide and 0.5 metres deep. Excavated soils would likely be temporarily stockpiled and reused for backfilling and landscaping of the trenches to pre-existing ground levels. The backfilled trench would be immediately stabilised, rehabilitated and revegetated.

The borefields collection pipeline would cross the Nambucca River at two locations and would be constructed using trenchless techniques. To enable the trenchless crossing, two 5 metre diameter shafts would need to be excavated either side of the river channel for both the launch and the receival of a closed face tunnel boring machine. Spoil generated would be returned through slurry pipelines to the surface and then to settlement tanks. Following installation of the pipeline, the launch and receival pits would be backfilled to pre-existing ground levels with appropriate soil materials.

Excess soil material would also be generated through drilling for bore placement and excavation of the launch and return pits for the directional drilling of the waterway crossings for the borefields collection pipeline.

The borefields collection pipeline would also cross several smaller waterways. Here, standard open trenching would be employed. The backfilled trench would be immediately stabilised, rehabilitated and revegetated.

Operation Phase - Impacts from changed appearance of inundated valley

The extent of the inundation area would be significant at the local level and would be partly visible from the perimeter of the watercourse from Bobo Road, the storage embankment, and from the air. The inundation area would not look too unnatural with the surrounding forest.

Factors most relevant to impact on the landscape character and visual amenity include:

- built structures and changes to landform, particularly the scale of the storage embankment and also the built form of realigned roads and new local access layouts and 4 additional transformer/ switchboard and telemetry power poles;
- vegetation changes particularly associated with the loss of vegetation within the inundation area; and
- land use changes including new recreation facilities, greater public accessibility to the waters edge.

Operation Phase - Impacts from changed appearance of borefields

With the exception of the proposed headworks, there are not expected to be any significant adverse impacts from either public locations or private properties caused by the proposed expanded borefield in the long term. A photomontage of the proposed and associated power transformer is shown in Figure 16-4.

LANDSCAPE IMAGERY
NOT TO SCALE

Figure 16-4 Photomontage of proposed borefields and power transformer

16.3.3 Views from Public Locations

View Point 1: Bellingen Road

Assessment of views

Proposed Storage

Bellingen Road is located south and southwest of the storage site. It provides the main access into nearby residences. Bellingen Road traverses a ridgeline in a north south direction. Bellingen Lane is located on a ridge and provides access to rural properties surrounding the Proposal.

The closest point from Bellingen Road to the storage embankment is over 800 metres to the west. An area of Bellingen Road is depicted in the view shed as having a low view to the storage embankment. This point is over 1 km from the embankment and is considered as potentially noticeable. During site inspections, the majority of the embankment structure would be concealed by vegetation and the undulating landscape (refer to Figure 16-5: view point 1). It would be highly unlikely to view the Proposal from Bellingen Road. As no views are possible from this location, the views have not been assessed against the desirable outcomes.

Figure 16-5 View to Storage embankment from Bellingen Road

Proposed Headworks Building

Views of the proposed headworks building would be available from Bellingen Road. The proposed headworks building would be of similar construction to the existing headworks building and would be built from brick and colourbond steel and painted to complement the surrounding rural character.

The views from Bellingen Road to the proposed headworks building have been assessed against the desirable outcomes with the following findings:

Desirable Outcome 1

The Proposal would not be viewed with the sky as a backdrop.

The proposed headworks building would not be viewed with the sky as a backdrop. It would be viewed against the backdrop of the riparian vegetation adjacent to the Nambucca River.

Desirable Outcome 2

The Proposal would not interrupt the view from any public location or nearby property to any landscape feature.

Currently broad views are available from this location. The view from this location takes in the landscape features of the vegetated riparian areas adjacent to the Nambucca River as well as the ridgelines and hills surrounding the Valley. The proposed headworks building would conceal portions of the riparian areas adjacent to the Nambucca River but not the ridgelines and hills surrounding the Valley.

The views of the vegetated ridgelines and hills surrounding the Valley are considered to be more important from a regional perspective.

Desirable Outcome 3

The Proposal would not detract from the visual amenity of an important visual or cultural element or landscape.

The proposed headworks building is not considered to detract from the visual amenity of an important visual or cultural element or landscape as the structure would be below the elevation of Bellingen Road and contained within the backdrop of the riparian vegetation adjacent to the Nambucca River.

Desirable Outcome 4

When viewed from a nearby property or a public location the Proposal would be of a scale appropriate to the setting.

The existing landscape has only a limited number of small built elements. The existing headworks building dominates its immediate location and it is intended that the proposed building would be more sympathetic to the rural environment and therefore of better visual appearance than the existing building.

Desirable Outcome 5

The Proposal would be of materials and forms that are sympathetic to the surrounds.

The proposed headworks building would only marginally intrude on the foreground of the new view and would be viewed within the adjacent riparian vegetation and distant hills. The material and form of the building are likely to complement the nearby vegetation and the distant hills.

While the proposed headworks building would dominate the immediate landscape and surrounds, it has been designed to "fit" into the rural environment.

Management Measures

- Ensure proposed headworks building is constructed of colours sympathetic with the surrounding environment.

<u>Proposed Power Transformer (South Creek)</u>

Views of the proposed power transformer would be available from North Arm Road. The proposed power transformer would be of similar construction to the existing transformers along

the Nambucca River (refer to Figure 16-3) and would be built from timer and steel to complement the surrounding rural character.

The views from North Arm Road to the proposed power transformer have been assessed against the desirable outcomes with the following findings:

Desirable Outcome 1

The Proposal would not be viewed with the sky as a backdrop.

The proposed power transformer would not be viewed with the sky as a backdrop. It would be viewed against the backdrop of the riparian vegetation adjacent to South Creek.

Desirable Outcome 2

The Proposal would not interrupt the view from any public location or nearby property to any landscape feature.

Currently broad views are available along both sides of North Arm Road to the riparian vegetation along South Creek and beyond. The proposed power transformer would conceal only small portions of the riparian area adjacent to South Creek but not the ridgelines and hills surrounding the Valley.

Desirable Outcome 3

The Proposal would not detract from the visual amenity of an important visual or cultural element or landscape.

The proposed power transformer is not considered to detract from the visual amenity of an important visual or cultural element or landscape as the structure would sit against the backdrop of the riparian vegetation adjacent to South Creek.

Desirable Outcome 4

When viewed from a nearby property or a public location the Proposal would be of a scale appropriate to the setting.

The existing landscape has only a limited number of small built elements typical of a rural environment. The power transformer would be no more imposing than a windmill or other farm infrastructure.

Desirable Outcome 5

The Proposal would be of materials and forms that are sympathetic to the surrounds.

The proposed power transformer would only marginally intrude on the foreground of the new view and would be viewed within the adjacent riparian vegetation and distant hills.

Management Measures

- Ensure proposed power transformer is constructed of colours sympathetic with the surrounding environment.

16.3.4 Views from Private Properties

Determining affected Residences

An initial review of the view sheds provided an indication as to which residences may have their views affected by the Proposal.

The site has the advantage of natural ridgelines screening on two sides. In fact the view shed modelling has indicated that many nearby view angles are screened by these ridgelines. However, some elevated land to the west (view point 2) and the east can potentially see some part of the Proposal without further screening. However, it is concluded from the view shed and site analysis that the site has a high capacity to absorb the visual impact due to surrounding topography and existing vegetation.

The undulating surrounds to the site, particularly to the west and south, either restrict views to the project site or promote views to the site. Following the identification of potentially affected properties, a site visit then narrowed the list to 8 properties. The properties were visited with one of the following outcomes:

- It was evident there were no existing views to the Proposal and the nearby property would not be visually affected by the Proposal;
- The property did have either partial or full views to the Proposal and their views may be affected by the Proposal.

Figure 16-1 provides the locations of the 8 potentially affected properties.

Assessment of views

Private Property 1 (Viewpoint 2)

This property is located at 124 Bellingen Road, Bowraville. The property has an undulating topography with its highest point at approximately 50 metres AHD and is elevated above the storage embankment. The property adjoins the project site to the west. The residential dwelling is located approximately 420 metres from the storage embankment on top of a ridgeline. The property is accessed via Bellingen Road.

The view to the Proposal from the residence is only partially screened by vegetation. It is likely that the majority of the inundation area and storage embankment would be visual from the residence. Western areas of the Proposal are unlikely to be visible due to vegetation screening this area from the residence and to the topography of the project site. The storage embankment as viewed from this residence would be fully vegetated; it is unlikely any concrete structures would be viewed.

The view from this property has been assessed against the desirable outcomes with the following findings:

Desirable Outcome 1

The Proposal would not be viewed with the sky as a backdrop.

The Proposal would not be viewed with the sky as a backdrop. It would be viewed against the backdrop of the vegetation and an undulating rural landscape within the northern and eastern extent of the site.

Desirable Outcome 2

The Proposal would not interrupt the view from any public location or nearby property to any landscape feature.

Currently broad views are available from this location. The view from this location takes in the landscape features of the vegetated ridgelines and hills. Existing vegetation would conceal portions of the Proposal. The Proposal would conceal the vegetation and distant hills east of the project site.

Therefore, while the Proposal would partially interrupt the views to the vegetated hills in the distance it would mainly function as an identifiable structure that integrates into the rural environment.

Desirable Outcome 3

The Proposal would not detract from the visual amenity of an important visual or cultural element or landscape.

The surrounding landscape to this site has a high visual amenity (see Figure 16-5). Views take in the undulating landscape and large areas of vegetation. The Proposal would be an additional and obvious built element within the project site. However, the design of the Proposal ensures the residence would gain additional water views from the site, which are also considered to be of high visual amenity. The storage embankment as viewed from this residence would be fully grassed or rock lined. The concrete spillway may be viewed from this location. The Proposal, though visible, would not result in an obtrusive structure and would be soften by existing vegetation. Whilst the embankment would be an obvious built element, it is unlikely to detract from the visual amenity of the existing rural context.

Desirable Outcome 4

When viewed from a nearby property or a public location the Proposal would be of a scale appropriate to the setting.

The existing landscape has only a limited number of small built elements. Given the design of the embankment and its location adjacent to undulating to steep terrain, the Proposal would not appear as a large foreign structure in comparison to the surrounding terrain view. The majority of the storage embankment would be covered in grassed or rock lined in order to prevent erosion and therefore would reduce the scale of the Proposal as it would blend in with the surrounding landscape.

Desirable Outcome 5

The Proposal would be of materials and forms that are sympathetic to the surrounds.

The Proposal would only partially vacate the foreground of the new view and would be viewed with a natural backdrop of vegetation and distant hills. The material and forms of the Proposal are likely to complement the nearby vegetation and the distant hills, especially the storage embankment which would vegetated. The remainder of the Proposal would be prominent but sensitive to the rural context.

While the Proposal would be dominant in the landscape and surrounds it has been designed to "fit" into the rural environment. The external storage embankment would be grassed or rock lined and therefore would complement the background.

Management Measures

- Maintain the existing vegetation between this property and the project site.
- Ensure storage embankment has sufficient vegetation to minimise the impact and complement the rural context.

Figure 16-6 Private Property 1 looking east towards Proposal

Private Property 2 (Viewpoint 3)

This property is located at 122 Bellingen Road, Bowraville (see Figure 16-6). The residence is located on a ridge and is approximately 580 metres south west of the storage embankment. The property adjoins the project site to the south. The property is accessed via Bellingen Road.

The view to the project site is screened by existing vegetation and a hill to the north. The vegetation surrounding the property is over 20 metres high and with the undulating landscape both would screen views to the project site from this location.

During the site visit the visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of site (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes.

Figure 16-7 Private Property 2 looking north towards Proposal

Private Property 3 (Viewpoint 4)

This property is located at 88 Bellingen Road, Bowraville. The residence is located within a valley and is over 900 metres south west of the storage embankment. The property is accessed via Bellingen Road.

The residence is surrounded by cleared grazing land with the nearest vegetation visible to the east (see Figure 16-7). Directly in the line of site to the Proposal is a residence on a ridge.

The undulating landscape and the residential buildings to the north would screen the view to the Proposal. Beyond this ridge is a large amount of vegetation, which would screen the views to the north east. Some views may be possible at the eastern proportions of this property.

During the site visit the visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of site (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes.

Figure 16-8 Private Property 3 looking north towards Proposal

Private Property 4 (Viewpoint 5)

This property is located at 101-124 Bellingen Road, Bowraville. The residence is located within a valley and is over 900 metres south west of the storage embankment. The property is accessed via Bellingen Road (see Figure 16-9).

Two buildings exist within this property, which includes a residence on the western side of Bellingen Road and a dairy shed on the eastern side. Both buildings are located over 1 kilometre from the Proposal and are accessed via Bellingen Road.

The Proposal would be located to the north east of this site. The Proposal would be screened by a ridgeline running in an east west direction and vegetation along this ridgeline. The eastern side of the storage embankment would also be screened by vegetation.

During the site visit, the visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of sight (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes.

Figure 16-9 Private Property 4 looking north east towards Proposal

Private Property 5 (Viewpoint 6)

This property is located at 1 Paulownia Place, Bowraville. The Proposal would be located to the north east of this site. The residential building is located over 1.1 kilometres from the Proposal.

The residence is surrounded by vegetation and is located on the southern side of a ridge. The vegetation surrounding the residence is fairly dense to the north. The view to the project site is screened by existing vegetation and the undulating landscape surrounding the residence.

A site visit was undertaken but full access into the property was not available, and the assessment was undertaken from the front gate. The visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of sight (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes.

Private Property 6 (Viewpoint 7)

This property is located at 1389 Rodeo Drive, Bowraville and access to the site is via Rodeo Drive. The Proposal would be located to the north of this site. The residential building is located over 2 kilometres from the Proposal and located on the main road into Bowraville. The residential dwelling is elevated above Rodeo Drive but at a lower elevation to the project site.

The view to the project site is screened by existing vegetation surrounding the residence (see Figure 16-10). The vegetation surrounding the property is dense and is over 10 metres high. The undulating landscape as well as the distance would screen the views to the Proposal.

During the site visit, the visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of sight (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes

Figure 16-10 Private Property 6 looking north towards Proposal

Private Property 7 (Viewpoint 8)

This is actually a group of buildings located along High Street and Young Street. These properties have been considered as one viewing location as they are all located along the one street and have fairly similar views to the Proposal. The properties include a primary school and a post office and are located within the village of Bowraville. The buildings are elevated above High Street and are over 2.3 kilometres from the Proposal. The surrounding buildings and vegetation surrounding the town would screen views to the Proposal. In addition, the distance from the Proposal would ensure that it would not be possible to view the site from any building in this vicinity.

During the site visit, the visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of sight (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes

Private Property 8 (Viewpoint 9)

This is actually a group of buildings located along Carbin Street and High Street. These properties have been considered as one viewing location as they are all located along the one street and have fairly similar views to the Proposal. The properties include mostly residential buildings and several churches along Carbin Street and are located within the village of Bowraville. All buildings are located on one of the highest points in Bowraville village. This group of buildings is over 3 kilometres from the Proposal.

The buildings along Carbin Street have broad views beyond the village to the surrounding undulating landscape. These views however are minor and the surrounding buildings and vegetation would screen views to the Proposal (see Figure 16-11). In addition, the distance

from the Proposal would ensure that it would not be possible to view the site from any building in this vicinity.

During the site visit the visual assessment concluded that the Proposal would not be viewed from this site and therefore would not be viewed against the sky from this location. The Proposal would be out of sight (or very minimal) and therefore would not interrupt the view to any landscape feature. There would be no long term visual impacts associated with the construction phase of the Proposal.

As no views were identified during the site visit from this location, the views have not been assessed against the desirable outcomes.

Private Property 9 (Viewpoint 10)

This property is Lot 3 DP 612962 with the dwelling on the property being located approximately 120 metres from the most northern proposed power transformer at South Creek. The views from the dwelling have been assessed against the desirable outcomes as per the assessment from North Arm Road in Section 16.3.3 and the same management measures applies.

Figure 16-11 Private Property 8 looking north on Carbin Street towards Proposal

Private Property 10 (Viewpoint 11)

This property is Lot 2 DP 1076377 with the dwelling on the property being located approximately 200 metres from the storage. The views from this dwelling would be obstructed towards the storage embankment and partially obstructed towards the inundation area by existing vegetation. It is likely that following construction, part of the inundation area would be visual from the residence. The view from this property has therefore been assessed against the desirable outcomes with the following findings:

Desirable Outcome 1

The Proposal would not be viewed with the sky as a backdrop.

The Proposal would not be viewed with the sky as a backdrop. It would be viewed against the backdrop of the surrounding vegetation and an undulating rural landscape within the northern and eastern extent of the site.

Desirable Outcome 2

The Proposal would not interrupt the view from any public location or nearby property to any landscape feature.

Currently closed views are available from this location. The view from this location takes in the close and immediate vegetation with some views of the vegetated ridgelines and hills. Existing vegetation would conceal portions of the Proposal.

Desirable Outcome 3

The Proposal would not detract from the visual amenity of an important visual or cultural element or landscape.

The surrounding landscape to this site has a high visual amenity, predominantly towards the south –west and this is reflected in the dwelling's design. The Proposal would not impact upon this view. However, the design of the Proposal ensures the residence would gain additional water views from the site to the north, which is considered to be of high visual amenity. Therefore, the Proposal though visible would be of a pleasing aesthetic and sculptural composition and well suited to the existing rural context.

Desirable Outcome 4

When viewed from a nearby property or a public location the Proposal would be of a scale appropriate to the setting.

The inundated valley as a result of the Proposal would not appear foreign in comparison to the surrounding vegetated landscaped and is appropriate to the setting.

Desirable Outcome 5

The Proposal would be of materials and forms that are sympathetic to the surrounds.

The Proposal would alter the existing vegetated catchment to one covered by water with a natural backdrop of vegetation and distant hills. The long-term view of the water would complement the nearby vegetation and the distant hills.

Management Measures

- Maintain the existing vegetation between this property and the storage.
- Ensure property owner is consulted throughout the construction phase.

16.4 Measure of Impacts

16.4.1 Impacts on affected properties or public locations

In terms of extent and significance of the Proposal on visual amenity, an assessment in relation to the identified sensitive receptors is undertaken. The following summary provides an overview of each of the affected locations and the visual impact in relation to the Proposal.

The overall rating has been provided for each of the potentially affected properties. This rating has been achieved by reviewing the summary of findings for each of the properties and making an assessment as to how each property rated relative to the 'desirable outcomes'. The following table presents a summary of the rating.

Table 16-2 Rating

Rating	' Desirable Outcomes' Conclusions
No impact	Achieved all desirable outcomes
Low visual impact	Fully achieved at least 5 of the desirable outcomes and impacts could be lessened through mitigation measures
Medium visual impact	Fully achieved at least 4 of the desirable outcomes and impacts could be lessened through mitigation measures
High visual impact	Achieved less than 3 of the desirable outcomes and it would be extremely difficult to lessen the visual impacts.

Table 16-3 Ratings for affected properties or public locations

Viewing Site	Summary of Findings	Potential Visual Impact
View Point 1: Bellingen Road	◗ Vegetation restricts views to Proposal from residence. ◗ Not possible to view the Proposal from residence.	No impact
Private Property 1 (Viewpoint 2), 124 Bellingen Road, Bowraville	◗ Construction works would be visible from property. ◗ Some long term visual impacts ◗ Proposal would not be viewed against the sky ◗ Storage embankment and inundation area would be highly visible ◗ Proposal would not interrupt views to distant hills. ◗ Proposal would be an obvious built element ◗ Proposal would be unlikely to detract from visual amenity of the existing landscape ◗ Materials & colours would contrast with natural backdrop. ◗ Vegetation would screen any view to the Proposal.	High
Private Property 2 (Viewpoint 3), 122 Bellingen Road, Bowraville	◗ Vegetation restricts views to Proposal from residence. ◗ Not possible to view the project site. ◗ Some possible views from the eastern boundary of the property.	Low
Private Property 3 (Viewpoint 4), 88 Bellingen Road, Bowraville	◗ Vegetation restricts views to Proposal from residence. ◗ Not possible to view the Proposal from residence.	No impact
Private Property 4 (Viewpoint 5),	◗ Vegetation restricts views to Proposal	No impact

Viewing Site	Summary of Findings	Potential Visual Impact
101-124 Bellingen Road, Bowraville	from residence. • Not possible to view the Proposal from residence.	
Private Property 5 (Viewpoint 6), 1 Paulownia Place, Bowraville	• Vegetation restricts views to Proposal from residence. • Not possible to view the Proposal from residence.	No impact
Private Property 6 (Viewpoint 7), 1389 Rodeo Drive, Bowraville	• Vegetation restricts views to Proposal from residence. • Not possible to view the Proposal from residence.	No impact
Private Property 7 (Viewpoint 8), High Street and Young Street	• Vegetation restricts views to Proposal from residence. • Not possible to view the Proposal from residence.	No impact
Private Property 8 (Viewpoint 9), Carbin Street and High Street	• Vegetation restricts views to Proposal from residence. • Not possible to view the Proposal from residence.	No impact
Private Property 9 (Viewpoint 10), North Arm Road	• Views available to proposed power transformer	Medium
Private Property 10 (Viewpoint 11), Bobo Road	• Vegetation restricts views to storage embankment with partial views to inundation area.	High

16.4.2 Impacts on Landscape Character

The corridor of vegetation within the valley would be extensively cleared to accommodate the inundation area. This body of water would be visually conspicuous where it adjoins the largely cleared areas to the south. Much of the inundation area would remain largely hidden within the surrounding vegetation. The proposed buffer areas may be able to extend the area of screening although this is not considered to be required from a landscape impact aspect of the Proposal.

The additional water area would create a distinct landscape element revealing the valley landform. This would provide greater visual diversity to the existing landscape adding value to views when travelling around and through the landscape. The expanded area of water would have the effect of making the waters edge more available to the public, both visually and potentially for physical access and enjoyment.

From a construction perspective, short term intensification of human activity would occur as earth material is extracted, spoil is distributed, and construction of the embankment is undertaken. Support developments are also required such as road works, site offices and workshops.

In the long term, a passive recreation area would be available to view the storage. These additional land uses could be considered beneficial in adding to the variety and interest in the

landscape, increasing public access to elements that are currently largely unseen, inaccessible and private.

The capacity of the landscape to accommodate the change would result in a negligible impact on the landscape.

16.5 Mitigation Measures

On a local visual catchment level, the changes are likely to be noticeable by a small number of residents, which are in the vicinity of the storage embankment and other infrastructure. The following mitigation measures are proposed to reduce the visual impact of the Proposal.

Access roads

- Seal Bobo Road to suppress dust.

Construction

- Liaise with affected property owners prior to and during construction to advise of progress and proposed treatments;
- Suppress dust as necessary;
- Do not allow waste to proliferate and clean up regularly;
- Remove redundant construction phase buildings and compounds; and
- Rehabilitate construction compound areas upon completion.

Operation

- Ensure the headworks building and power transformers are constructed to complement the surrounding rural landscape; and
- Grass or rock line the storage embankment so that it blends into the natural landform of the area.

17 Waste Management and Resource Use

17.1 Introduction

The Proposal has the potential to generate a significant amount of vegetative matter and extracted earth and associated construction material. This Chapter identifies the potential waste management issues associated with the Proposal and the management measures to reduce any potential environmental impacts.

Table 17-1 outlines the Director-General's requirements and where they have been addressed.

Table 17-1 Statutory Requirements

Statutory Authority	EIS Requirements	Where Addressed
Director-General's requirements (DoP)	◗ Assessment of waste management, particularly the generation of solid and liquid wastes during construction and operation, and how this waste would be reduced, reused, recycled or disposed of, in accordance with the DECCW guideline *Assessment, Classification and Management of Liquid and Non-liquid Waste.*	Sections 17.6 and 17.6.3
	◗ Outline measures to minimise the consumption of natural resources, outline the measures to avoid the generation of waste and promote the reuse and recycling and reprocessing of any waste, measures to support any approved regional or industry waste plans.	Sections 17.7

The objective of this Chapter is to ensure waste from the construction and operation of the Proposal is managed appropriately and the associated impacts are minimised. The waste management hierarchy is the underlying principal to the management of waste materials generated during construction and operation of the Proposal. The waste management hierarchy consists of avoidance; reuse; recycling; recovery of energy; treatment; containment; and disposal.

To assess the waste types and the most appropriate form of management, this assessment:

- Identified the major types, sources, quantities and, where available, characteristics, of waste expected to be generated during the construction and operation of the proposal;
- Reviewed the legislative and policy framework for waste management; and
- Identified options for avoiding, mitigating and managing major waste streams and to evaluate these options in accordance with the waste hierarchy.

17.2 Existing Conditions

Policy, Legislative, and Regulatory Guidelines and Standards

In NSW the legislation and policies that govern the management of waste include:

- *Waste Avoidance and Resource Recovery Act 2001;*
- *Waste Avoidance and Resource Recovery Strategy 2007;*
- NSW Government's Waste Reduction and Purchasing Policy 2007;

- *Protection of the Environment Operations Act 1997* outlines the requirements for waste management;
- *Contaminated Land Management Act 1997* defines the requirements for the management of contaminated materials; and
- Waste Classification Guidelines Part 1: Classifying Waste (DECCW, 2008) defines the classifications of waste and their management requirements.

Existing Environment

The existing waste production and management within the study area are expected to be characteristic of a largely undeveloped rural environment. The land use comprises primarily grazing land, with beef and dairy cattle the major industry, as well as heavily forested areas.

The land has either been cleared in the past for agriculture or is covered in vegetation. Large areas of commercial timber plantation are found within and adjacent to the inundation area.

The key waste sources within the existing environment are therefore expected to include domestic waste and sewerage associated with farm holdings. Other waste produced would be minimal and confined to some scrap metals, waste timber, oil/lubricants, insecticides and herbicides. Animal wastes as well as organic debris from the timber plantation would be additional 'waste' sources, though they are reusable for nutrient content.

Nambucca Waste Management Facility

Nambucca Waste Management Facility is the nearest to the site and is located on Old Coast Road, Nambucca Heads. The hours of operation are between 7.30 am to 4.30 pm seven days a week. The facility is closed Public Holidays.

The Nambucca Waste Management Facility acts as a Transfer Station for the Coffs Coast Waste Service, an active landfill for some items and a recycling centre for some items. The Transfer Station accepts source separated waste deposited (from small vehicles, i.e. sedans, station wagons, 4WDs, 6x4 trailers, vans and utilities) into bulk bins in the following categories:

- Recycling – cardboard, paper, glass bottles, PET, HDPE etc;
- Domestic Mixed Waste – plastics, nappies, domestic food waste;
- Other Waste – concrete, bricks, plaster board, timber offcuts, furniture, ceramics etc;
- Greenwaste – greenwaste and raw timber; and
- Large vehicles i.e. trucks carrying mixed domestic type waste would be directed to Coffs Harbour's Waste Facility for disposal.

The items the Nambucca Waste Management Facility accepts in the landfill includes:

- Mixed Building and Demolition Waste;
- Concrete and Masonry;
- Greenwaste and Raw Timber;
- Clean Fill; and
- Asbestos.

Items recycled at Nambucca Waste Management Facility include:

- Scrap Metal & White Goods;
- Motor Oil;
- Batteries;
- Car bodies;
- Hazardous Chemicals (class 3 flammable and class 6 toxic); and
- Concrete and masonry products.

Unacceptable items include:

- Contaminated soil or fill,
- Tyres;
- Liquid waste;
- Medical waste;
- Large and medium deceased animals; and
- Large compactors and trucks carrying mixed domestic waste and greenwaste materials.

17.3 Construction Materials Required

17.3.1 Embankment Materials

Based on the investigation carried out on site, material for the clay core and residual fill can be sourced from within the storage site. Table 17-2 shows the quantities for each material required for the construction of the embankment.

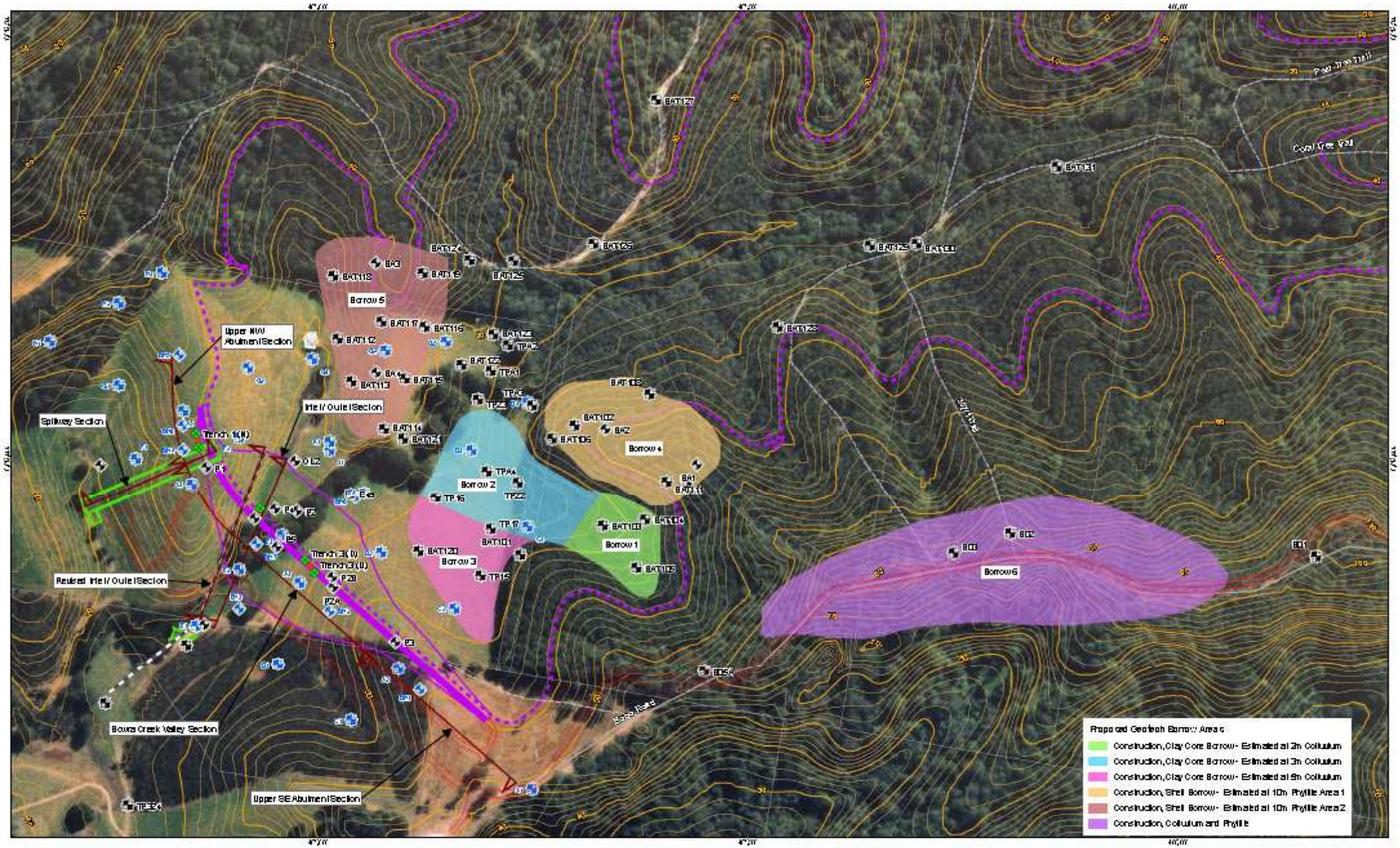
Table 17-2 Material for Embankment

Zone	Description	Estimated Quantities (m^3)
Zone 1	Colluvial Clay (Core + Cut-off)	56,800
Zone 2	Sand Filter	21,000
Zone 3	Residual Fill	299,100
Zone 4	Upstream Rip Rap	18,900
Zone 5	Downstream Toe Rock	1,600
Zone 6	Rock	320

Figure 17-1 shows the location and extent of the borrow areas investigated to provide the quantities of clay core and shell materials required for the storage embankment.

Zone 1

Borrow areas 1, 2 and 3 were investigated as a source of colluvium for clay core while Borrow Areas 4 and 5 were investigated as sources of residual soil and weathered phyllite for the shell material, upstream and down stream of the impervious core within the embankment.



1:4,000 (at A3)

0 25 50 100 150 200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

- Fence Line
- Road
- 2m Contours
- Cadastre
- Proposed Storage Wall
- Proposed Inundation Area
- Borehole - GHD
- Test Pit - GHD
- Trench - GHD
- Borehole - Woodward Clyde
- Test Pit - Woodward Clyde
- Location of Geotechnical Cross Section
- Outlet Pipe
- Spillway
- Preliminary Road Design

GHD

CLIENTS | PEOPLE | PERFORMANCE

Nambucca Shire Council
Bowraville Off River Storage

Job Number	22-14133
Revision	A
Date	07 OCT 2009

Borrow Areas

Figure 17-1

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Other materials such as aggregates and sand for filters, drains and concrete and rock for rip rap and erosion control are not available on site and would be obtained from commercial sources and these sources are discussed in Section 7 of the Factual Geotechnical report.

Borrow Areas 1, 2 and 3 are situated in colluvium in the floor of the reservoir basin immediately upstream of the proposed storage and contain the most clayey material on site to be used as clay core. The deeper colluvial soil that has accumulated in the floor of the valley is more clayey that the residual soils from which they are derived and more clayey than the alluvium. They therefore represent the most suitable impervious core material as the higher clay content results in a lower permeability and higher shear strength. The average depths of colluvium are:

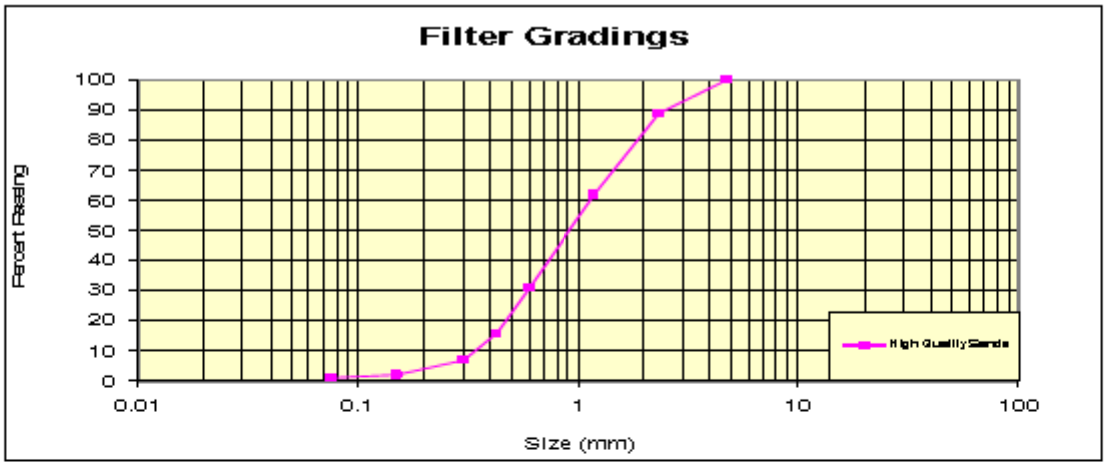
- 3.0m in Borrow Area 1,
- 2.2m in Borrow Area 2,
- 3.6m in Borrow Area 3.

The quantities in the three areas have been estimated as 26,000 m^3, 35,000 m^3, and 35,000 m^3, in the three borrow areas respectively, giving a total of 96 000 m^3 of clay core. This is sufficient for the Proposal.

Zone 2

Sand filter for Zone 2 would be imported from off site. High Quality Sands from Bellinger River, about 45 km away from the storage site has been identified to be able to provide suitable material for sand filter. The grading of the sand is provided in Figure 17-2.

Figure 17-2 Sand Grading for Zone 2



Zone 3

Borrow Areas 4 and 5 are situated on two ridges upstream of the storage and on either side of the river. The borrow areas contain a thin veneer of clayey colluvial soil which overlies a clayey residual soil layer above extremely and highly weathered phyllite. These materials are all suitable as shell material. The estimated depths of materials of clayey soil and weathered materials are about 3.1 m and 12.5 m in Borrow Area 4 and 2.5 m and 17.5 m in Borrow Area 5, respectively. The quantities of soil and of weathered phyllite in the two areas have been estimated as 95,000 m^3 and 291,000 m^3 in Borrow Area 4 and 112,000 m^3 and 785,000 m^3 in Borrow Area 5 respectively, giving a total of 207,000 m^3 of soil and 1,076,000m^3 of weathered

phyllite or a total of 1,283,000 m^3 of shell material. There is thus sufficient material for the Proposal.

Borrow Area 6 on the ridge top on the left side of Bowra Creek Valley is outside the reservoir basin but has been investigated as a possible source of embankment material for any future upgrades. There is virtually no colluvial material on top of the ridge in this borrow area to be available as a source of clay core material. The depth of clayey residual soil has an average of 2.4 m and the extremely to highly weathered phyllite is expected to be of the order of 10 m, yielding quantities of 167,000 m^3 and 696,000 m^3 respectively. Thus a total of about 863,000 m^3 of shell material is available.

It is envisaged that the clayey colluvial and residual soils would be mixed with the weathered phyllite for use in the embankment shells.

Table 17-3 shows the quantities of materials available from the six borrow areas:

Table 17-3 Available Material Quantities

Borrow Area	Clay Core	Shell Material		
		Clay Soil	Weathered	Total
	m^3	m^3	m^3	m^3
1	26,000	0	0	0
2	35,000	0	0	0
3	35,000	0	0	0
Total:	96,000	0	0	0
4	0	95,000	291,000	386,000
5	0	112,000	785,000	897,000
Total:	0	207,000	1,076,000	1,283,000
6	0	167,000	696,000	863,000

There is thus sufficient clay core and shell material in the basin for the Proposal.

Zone 4 and 5

As for the rip rap and downstream toe rock, a number of sites within feasible haulage distance from the site were considered. A hard rock granite quarry near Valla is considered.

17.3.2 Pipelines and Pumps

Materials Required for the Rising Main Construction

The rising main would have the following characteristics:

- Material: Ductile Iron Cement Lined (DICL)
- Pressure Rating: PN20 (would be sufficient for design pressure when confirmed during detail design)
- Nominal Diameter: DN600

- Internal Diameter: 643 mm
- Outside Diameter: 667 mm
- Length of Pipeline 1,990 m

Concrete encasement is likely to be required for the Bowra Creek and Bellingen Road crossings. This would be specified in the detailed design.

Jointing

Flexible rubber ring joints are proposed. Flanged connections may be used to connect to fittings along the main and at the pumping station and storage outlet ends.

Anchorages

For flexibly jointed pipes thrust blocks are required at bends and other fittings to resist thrusts generated by the internal pressure.

Corrosion Resistance

The soils aggressiveness tests in the Geotechnical Report indicate pH levels from 4.5 to 7 and chloride and sulphate percentages generally less than 0.01%. No CPR testing was undertaken. It would therefore be reasonable to assume that wrapped DICL pipe would last at least 50 years and possibly 100 years in most areas.

Materials Required for Inlet

The material required for the Inlet works would be as follows:

Table 17-4 Materials Required for Inlet

Materials	Units	Quantities
ϕ600 mm pipe	m	8
ϕ600 mm pipe 90° bend	No	1
Sand Filter	m3	331
Backfill	m3	1,673
Trash Screen	No	2

17.4 Materials Required for Outlet Works

The material required for the outlet works would be as follows:

Table 17-5 Materials Required for Outlet Works

Inlet Structure & Outlet Pipe	Units	Quantities
Concrete (tower)	m3	418
Concrete (pipe encasement)	m3	537
ϕ1000 mm pipe	m	179

Inlet Structure & Outlet Pipe	Units	Quantities
ϕ600 mm pipe	m	8
ϕ1000 mm pipe 90° bend	No	3
ϕ600 mm pipe 90° bend	No	1
Sand Filter	m3	331
Backfill	m3	1,673
Sliding Gate	No	2
Sliding Gate Guide	No	2
Trash Screen	No	2
Transparent flow outlet		
ϕ1000 mm pipe	m	30
Head Embankment	No	1
Velocity Dissipater	No	2

Materials Required for Apron and Dissipater

To reduce flow velocity downstream of the spillway and to reduce the risk of scouring the riverbed and undermining the downstream toe of the storage, a stilling basin would be provided at the downstream end of the spillway chute, where it meets the reentrant channel that leads to Bowra Creek. The design of this stilling basin shall be based on design flood of 1 in 1000 AEP event, which is lower than the spillway design flood. Floods greater than the 1 in 1,000 AEP event shall require maintenance undertaken in the chute. The stilling basin shall be designed in accordance with the design parameters given USBR Guidelines for Stilling Basins (refer section 10.3).

Table 17-6 Spillway Materials

Spillway	Units	Quantities
Slab	m3	1,470
Side Embankment		586
Chute Blocks		0.696
Baffle Blocks		0.92
End Sill		7.7
Total		2,065
ϕ100 mm slotted under drain pipe	m	692
Traverse Underdrain Clean Out Point	No	14

Spillway	Units	Quantities
Longitudinal Underdrain Clean Out Point	No	3
Under-drain Outlet Cover	No	3
Free Draining Gravel	m^3	57

Materials Required for Proposed Borefields

Bores

Several borefield layout options have been developed based on different configurations of 39 bore locations within the floodplains of the Nambucca River and South Creek. The borefield layout involves construction of 15 additional bores along the Nambucca River and 9 bores along South Creek.

The constructed bores would have limited surface expression, involving a concrete bore head and pump housing covered with a steel lid at ground level. As a result the constructed bores would not alter localised flood flow hydraulics and are therefore not expected to increase the propensity for the scour of floodplain soils during flood flows.

Borefield Pipelines

To link the borefields with the existing headworks and the storage transfer pipeline, a borefields collection pipeline would be constructed. This would involve excavation of a trench within the alluvial soils to average depths of approximately 3 m below ground level. It is expected that the excavation of soils could be undertaken using conventional earthmoving equipment and / or trench excavating equipment. Excavated soils would likely be temporarily stockpiled and reused for backfilling and landscaping of the pipeline trench to pre-existing ground levels. The backfilled trench would be immediately stabilised, rehabilitated and revegetated.

The existing local area power supply would be extended to provide power to the bore pumps as follows:

- Placement of two additional transformers to supply power to the proposed bores along the Nambucca River; and
- Placement of two additional transformers to supply power to the proposed bores along South Creek.

The transformers would be placed on poles and connected to the existing power grid via overhead lines. Underground cabling would link the transformers to the each of the individual bore pumps. Cables would be at a minimum depth of 500 mm. This would involve excavation of trenches of up to 1 metre wide and 0.5 metres deep. Excavated soils would likely be temporarily stockpiled and reused for backfilling and landscaping of the trenches to pre-existing ground levels. The backfilled trench would be immediately stabilised, rehabilitated and revegetated.

The borefields collection pipeline would cross the Nambucca River at two locations and would be constructed using trenchless techniques. To enable the trenchless crossing, two 5 metre diameter shafts would need to be excavated either side of the river channel for both the launch and the receival of a closed face tunnel boring machine. Spoil generated would be returned through slurry pipelines to the surface and then to settlement tanks. Following installation of the

pipeline, the launch and receival pits would be backfilled to pre-existing ground levels with appropriate soil materials.

Excess soil material would also be generated through drilling for bore placement and excavation of the launch and return pits for the directional drilling of the waterway crossings for the borefields collection pipeline.

The borefields collection pipeline would also cross several smaller waterways. Here, standard open trenching would be employed.

Table 17-7 Materials Required for Bores and Pipelines

Bores	Drill bores, install concrete wellhead, etc		24
	Pipes, strainer, valves, meters, fillting, etc (150mm)	No	24
Pumps	Grundfos Submersible Pumps		
	SP95-2	No	1
	SP95-3	No	7
	SP95-4	No	7
	SP60-6	No	9
Pipeline			
	DN 150	m	530
	DN 200	m	580
	DN 250	m	530
	DN 300	m	1840
	DN 375	m	450
	DN 400	m	600
	DN 500	m	480
1.5.1	River Crossings 300 Ø	No	1
1.5.2	River Crossings 500 Ø	No	1

Materials Required for Pump Station

The Raw Water Pumping System comprises:

- Raw Water Collection Tank, receiving water from the borefield pumps;
- DN600 inlet manifold for pumping station;
- DN600 Inlet manifold actuated valve for water returning from Off-River Storage;
- DN500 pump suction pipes and butterfly isolation valves. Valves would be fitted with electric actuators;

- 3 x 75kW Raw Water Pumps and motors (1 to 2 duty pumps delivering between 25 and 40ML/day);
- 1 x 30kW Raw Water jockey Pump and motor [delivering 3ML/day];
- Automatic Strainers with backwash valve (if required);
- DN375 pump discharge pipes, non-return valves and metal seated pump delivery control/isolation valves. Valves would be fitted with modulating electric actuators;
- Pump suction and discharge pressure gauges;
- Pump discharge flow switches (paddle type);
- Automatic air release valves on pump discharge pipes;
- Delivery manifold for the Raw Water Pumping Station;
- Delivery manifold pressure transmitter;
- DN500 delivery manifold manual gate valve;
- Electromagnetic flowmeter on transfer main to Off-River Storage to measure flow in both directions;
- Strainer backwash debris pump(s) (if required);
- Transfer main running between the Raw Water Pumping Station and the Off-River Storage;
- Pigging entry station; and
- Micro hydro turbine (potentially).

17.5 Resource Availability

17.5.1 General Proximity of Local Rockfill and Sand Supplies to Storage Site

A location plan of potential hard rock quarries and sand supplies, within a 45 km haulage radius from site, is presented below in Figure 17-3. A brief summary of the hard rock and sand supplies near site is also presented in Table 17-8.

Details of the local rockfall quarries and sand supplies are described in Sections 17.5.2 and 17.5.3. It is noted that the nearest cement suppliers in Macksville, south of the Proposal, use the listed hard rock quarry crushed gravel and sand sized material.

Figure 17-3 Location of Hard Rock & Sand Supplies near Proposal

Table 17-8 Summary of Hard Rock & Sand Supplies near Proposal

Name of Supply/Quarry	Location	Operator	Material	Approximate Haulage Distance to Storage Site (km)	Approximate Lifespan of Resource
Marriot's Quarry	Valla	South-East Excavations	Adamellite / Granite	28	40 years
Nambucca Valley Gravel	Macksville/Scotts Heads	Mid Coast Concrete & Quarries	Schist / Argillite	22.5	115 years
Bellinger River	Raleigh	High Quality Sands	Sand	45	Possibly >100 years

17.5.2 Local Rockfill Quarries

Marriot's Quarry (Valla)

Marriot's Quarry is located on Valla Road near Valla and is situated on a lease of approximately 40 hectares. As noted in Table 17-8, the quarried rock type is 'adamellite', which is defined in geological dictionaries as a variety of granite containing a calcium-bearing plagioclase feldspar.

This operation (formerly managed by Gus Munroe) recently came under new ownership by South-east Excavations and the quarry is currently about 30 m deep and laid out over three benches as a two stage operation (Stages 1 & 2), with the deeper / fresher rock and southern extension into a hillside part of Stage 2 development. The expected lifespan of the operation is approximately 40 years, with approximately one million tonnes of granite still to be mined in the hillside.

Apart from offering a substantial supply of rip rap material (2 – 3 tonne or one cubic metre sized blocks), the quarry has a crusher and screening plant capable of producing gravel product of 20 mm, 10 mm, 7 mm & 5mm size. A new 'Barmac' crusher produces a sub-angular to rounded gravel and sand product, so there is also potential manufactured sand supply from this operation.

The potential haulage route to the storage is approximately 28 km via the Pacific Highway and Wirimbi Road. It is noted that a more direct route to the storage site via Valla Road has been eliminated as part of the GHD traffic impact assessment, due to the narrow width and currently rough condition of the road.

Nambucca Valley Gravel Quarry (Macksville)

'Nambucca Valley Gravel' quarry is located just east of the Pacific Highway (about 150 m south of the Scotts Head intersection) and approximately 5 km south of Macksville.

The Stage 1 lease is approximately 18.5 hectares, with proposed development into a hillside to the east. The expected lifespan of the operation is approximately 115 years.

As noted in Table 17-8, the quarried rock type is 'described as 'schist', however its full petrological description is "biotite muscovite chlorite schist". The fresh rock material is hard and

grey coloured with a slaty blocky cleavage and resembles an argillite rock type. East of the main quarry near Scotts Head is a subsidiary quarry in decomposed granite, that is used to supplement fines for preferred gradings of the road base product.

This relatively young operation (formerly Boral) is several years old and operated by Mid Coast Concrete & Quarries and is currently mining Stage 1 development.

This quarry also offers potential rip rap sized material with typical blasted rock sizes ranging from 0.2 to 2 m, with abundant rectangular blocks of 1.2 m size. The crusher produces a range of cobble and ballast sized material ranging from 7 mm, 10mm & 20 mm gravel as well as GB road base, sullage trench blend and gabion size rock. An abrasion index of approximately 44 and polishing aggregate friction angle of 56 have been confirmed for the product.

The potential haulage route to the proposed storage is approximately 22.5 km via the Pacific Highway and Rodeo Drive.

17.5.3 Local Sand Supplies

Bellinger River, Raleigh

Dredged sediment from the Bellinger River near Raleigh is the nearest supply of commercial natural sand product.

Formerly known as 'Raleigh Sands', the current owners 'High Quality Sands', dredge approximately 3,000 – 4,000 tonnes of sediment per month from the Bellinger River. The source material is a mixture of granitic and basaltic material, with a small percentage of organics (mainly charcoal).

Apart from rough screenings (river gravel & aggregate) and fine screenings (fine gravel), the main product is coarse sand (typically >1 mm) with 75 micron passing. There is a plan to upgrade the plant shortly to enable separation of charcoal and organics via a 'classifier' water jet system. Some limited test data covering gradings is attached in Appendix F.

The main disadvantage of this sand supply is the 45 km haulage distance to the storage site via the Pacific Highway and Wirrimbi Road/Rodeo Drive. However, there is a high volume of potential commercial sand supply from this operation.

Marriots Quarry, Valla

As described in Section 17.5.2, the above hard rock quarry has a new 'Barmac' crusher capable of producing gravel and sand product from finely crushed granite. This is a potential alternative source of potential filter grade sand in the future, although QA specifications and supply of this product would require confirmation. The advantage of potential sand supply from this quarry is that it is relatively close to the storage site compared to the above operation at Raleigh.

17.5.4 Other Construction Materials

Discussions with local and interstate suppliers in relation to the more significant items such as pumps and pipelines reveals that there would be no impediment to the stocking of all necessary materials and equipment to facilitate construction of the Proposal.

17.6 Impact Assessment

The main aspects of the Proposal include expanding the existing borefield by 24 bores, constructing a pumping station, constructing a collection tank, constructing a transfer pipeline and establishing an off-river storage. All these works would create waste during their construction and operation.

17.6.1 Construction Waste

Waste generation during construction would vary according to the design and hence the materials required for construction. The waste generated during the construction of the Proposal would include the following:

- Excavated material from bulk earthworks, including soils and rock;
- Vegetative matter (green waste) from clearing of vegetation prior to construction of the access road, borefield, pipelines and off-river storage;
- Excess construction materials, such as concrete, steel and timber;
- General construction wastes including material off-cuts, packaging, chemical containers, waste concrete and waste lubricants;
- Construction camp and site office waste including domestic solid waste and wastewater;
- Liquid wastes, such as waste fuels, oils and chemicals from plant and machinery maintenance;
- Wastewater from dewatering activities;
- Human waste and sewage generated at amenity facilities at the construction compounds; and
- General garbage and recyclables.

A summary of the types of waste and estimates of quantities for the major waste streams produced during the construction of the Proposal is provided in Table 17-9.

Vegetation within the inundated area has been assessed and mapped. All vegetation within the inundation area would be cleared prior to the filling of the storage. Details of the methodology for vegetation removal are provided in Chapter 9 – Terrestrial and Aquatic Ecology.

All commercially millable timber would be removed in the first instance by Forests NSW, under a current approval, as part of the acquisition agreement between Forests NSW and NSC. Vegetation unsuitable for milling would be chipped on site to provide mulch for landscaping, or made available for habitat either on-site or for local revegetation projects. Excess mulch would be transported within the LGA for use as either bio-filter material or for other revegetation purposes. It is not envisaged that waste vegetation would be taken to the NWMF. If burning on site is required, pit burning has been identified as the most appropriate method of burning as it reduces smoke generation and reduces the emissions generated from open windrow burning. Transfer of mulch to NWMF would be considered a last resort.

The materials required for storage embankment including the rock armour (20,800m^3), filter sand (21,000m^3), clay core material (86,800m^3) and fill material (299,100m^3) would be available on-site or from local quarries and would be ordered to ensure that excess or waste material was minimised.

Inert soil and rock from excavation would be incorporated into the embankment, used as fill downstream of the storage embankment or in recreation areas where fill is required or where mounding would add to visual appeal. There is not expected to be any excess inert soil or rock beyond that which can be used within the embankment. All topsoil would be stockpiled separate to other fill material for redistribution post-construction. Material awaiting use during construction would be placed in designated stockpile storage areas and these would be graded with appropriate slope and configuration to ensure stability and to minimise the potential for erosion.

The materials required for the borefields, transfer pipeline, collection tank and pump station including pipelines and pumps would be available from local and interstate suppliers and would be ordered to ensure that excess or waste material was minimised. Building materials, concrete, timber and metal off cuts and plastics from construction would be re-used on site where practicable. Recyclable materials would be placed in designated bins whilst other material would be disposed of as general waste to the Nambucca Waste Management Facility.

The liquid wastes generated during the construction of the storage including waste oils, fuels, lubricants, tyres, batteries, oily air filters, paints, resins, solvents, sewage sludges and residues, spill clean up materials and water, soiled rags, drums and soils containing liquid wastes would be recycled where possible. The management of liquid wastes (collection, transport, tracking, treatment and disposal) would be in accordance with DECCW guidelines, including appropriate licensing of the contractor, transport vehicles and facilities.

Wastewater from the construction workforce facilities would be collected in holding tanks and transported to the local Bowraville wastewater treatment plant by licensed carriers.

Table 17-9 Waste Classification - Construction

Waste Type	Waste Classification[1]	Estimated Quantity	Comment
Construction			
Excavated Material	General Solid Waste (non-putrescible)	Materials required for embankment include: • Rock armour 20,800m^3; • Filter sand 21,000m^3; • Clay core 56,800m^3; • Fill material 299,100m^3;	There is not expected to be a significant amount of excess of excavated material, as only that material required for construction purposes would be excavated. However, the quantity of excess material would depend on the suitability of the material excavated. Earthworks for roads, transfer pipeline, pump station, collection tank and bores may also create some material. Excess material would be reused for backfilling, rehabilitation or levelled throughout the inundation area.

Waste Type	Waste Classification[1]	Estimated Quantity	Comment
Vegetation Matter	General Solid Waste (non-putrescible)	80.09ha. Millable timber would be sold to local timber mills	Vegetation waste would be created from the clearing of the 80.09ha within the inundation area and clearing associated with the transfer pipeline and access roads. Non-millable timber would be mulched or used for habitat in rehabilitation works either on-site or within the LGA. Some material may be burnt on site.
Construction Waste	Comprises a range of waste classifications including non-putrescible and putrescible waste.	< 50kg of pipework < 200kg concrete/ concrete block <250kg of general building waste	The main work items associated with the proposal are expected to generate waste including the following: ◗ Structures – concrete, structural steel, light steel framing, masonry, woodwork; ◗ Enclosures – roofing, cladding, insulation, windows, glazing, doors, hardware, painting, miscellaneous fixtures; ◗ Hydraulic installations – stormwater, sanitary services, water, domestic gas; ◗ Electrical installations – general electrical equipment, wiring and accessories, switchboards, luminaires, communications (including computers), electronic security, fire detection; ◗ Mechanical installations – general mechanical requirements, mechanical equipment, equipment fabrication and installation, ductwork, mechanical pipe work, mechanical insulation; and ◗ External works – paving, roads, car park, fencing, landscape.
Liquid Wastes	Liquid wastes	Up to 500 litres/ day < 20 litres Up to 300 litres/ day	Liquid wastes are likely from: ◗ Dewatering of trenches and the storage area during constructions. ◗ Excess paints and glues associated with construction of the structures. ◗ Sewage from toilets and basins.

Waste Type	Waste Classification[1]	Estimated Quantity	Comment
Miscellaneous Waste	Comprises a range of waste classifications including non-putrescible and putrescible waste.	< 50kg	This is waste which does not necessarily fit into any of the above waste sources or types but which still could comprise a proportion of the total construction waste stream. It is expected to comprise: empty chemical containers; and used personnel protective equipment (PPE).

[1] According to *Waste Classification Guidelines. Part 1: Classifying Waste* (DECCW, 2008)

17.6.2 Operation Waste

The operation of the Proposal is unlikely to produce significant waste emissions. Waste would be generated predominantly from maintenance activities, and recreation areas. All wastes from maintenance activities would be removed from site and disposed of in appropriate waste disposal facilities.

Permanent on-site toilet and washroom facilities would be provided. This system would incorporate a septic system, designed in accordance with current best practice to meet NSC requirements and would be maintained regularly by NSC.

The operation of the headworks to and from the borefields and storage would generate very little waste. The gates on the spillway would require maintenance, and small amounts of waste hydraulic oils and greases may be generated.

Day to day rubbish associated with the headworks would be collected and taken off-site to the Nambucca Waste Management Facility as required.

Waste from the viewing area (i.e. picnic and BBQ facilities) would be generally only domestic rubbish. Signs would be erected requesting any waste to be transported off site and disposed of appropriately.

The operation of the Proposal is unlikely to produce any other significant waste emissions.

The waste impacts generated during the operation of the Proposal would include the following:

- Scheduled and unscheduled maintenance activities associated with the operation of the proposal are expected to result in the generation of small quantities of solid inert, putrescible and non-putrescible waste;
- Human waste and sewage generated at amenity facilities at the viewing area.

A summary of the types of waste and estimates of quantities for the major waste streams produced during the operation of the Proposal is provided in Table 17-10.

Table 17-10 Waste Classification - Operation

Waste Type	Waste Classification[1]	Estimated Quantity	Comment
Operation			
General Operation Wastes	Comprises a range of waste classifications including non-putrescible and putrescible waste.	Waste is likely to vary significantly from day to day. <20kg/ day	The waste generated by the plant staff and recreation area is expected to comprise the following broad categories: • paper or cardboard including newspapers, magazines, • packaging and stationery; • plastic packaging and other plastic items; and • prescribed wastes commonly produced, including expired batteries, cleaning chemical containers, fluorescent tubes and clinical waste.
Liquid Wastes	Liquid wastes	<20 litres of liquid waste < 1,200 litres of sewage/ grey water/ day	Liquid wastes are likely from: • Excess paints and glues associated with maintenance. • Sewage from toilets, basins and showers.

[1] According to *Waste Classification Guidelines. Part 1: Classifying Waste* (DECCW, 2008)

17.6.3 Spill Containment and Remediation

Standard procedures for the storage, handling, disposal and spill response for potentially hazardous waste materials would be applied. This includes the use of spill containment material and spill clean-up kits. Sites that become contaminated would be investigated, managed and remediated in accordance with the requirements of the contaminated land provisions of the EP&A Act.

17.6.4 Hydrocarbons and Hazardous Wastes

Chemicals, fuels, oils and any other substances that, if spilled, would cause pollution or contamination of the land or water, would be stored appropriately to minimise the risk of environmental impact. Chemical storage would comply with Australian Standards and Material Safety Data Sheets (MSDS) requirements. MSDS for products kept on-site would be readily available to employees and contractors.

Smaller quantities of chemicals, fuels and oils would be stored in self-bunded pallets, within a bunded area in the work compound, or in a bunded container on-site.

All waste products (e.g. oil / water separator waste, sludges and residues) containment would be within weatherproof, sealed and bunded areas to ensure stability of the waste containment receptacles and prevent any leakages or spills. Regular inspections would be carried out of the tanks, bunds and storage areas to ensure integrity. Hydrocarbons and hazardous wastes present on site during construction are outlined in Chapter 18 – Hazard and Risk.

17.6.5 Management of General Wastes

During construction, colour-coded, signed bins would be used to segregate and collect general wastes, paper and recyclables. The bins would be located throughout site offices and workshop areas to maximise waste recovery.

These bins would be emptied into larger bins or skips regularly. All smaller bins and larger bins or skips would have lids, to reduce the potential for attracting insects and vermin. General wastes would be collected regularly and transported for disposal to landfill.

17.7 Mitigation Measures

It is an environmental protection objective that all waste would be managed so as to avoid any direct impacts on the health of people working in the study area and to minimise the risk of impacts on the receiving environment.

Waste materials generated during construction and operation of the Proposal would be managed in accordance with the principles and the waste management hierarchy. Prior to commencing construction works a detailed Waste Management Plan would be prepared. The Waste Management Plan would incorporate the principles of the waste management hierarchy and the mitigation measures indicated in Table 17-11.

Every contractor working on the site during construction and operation would be educated on the appropriate waste management practices identified in the Waste Management Plan. Audits of the waste management would be undertaken on a six monthly basis during construction and operation of the facility.

Based on the current understanding of the waste to be generated during the construction and operation of the Proposal, most would be able to be disposed of at the Nambucca Waste Management Facility if necessary.

Table 17-11 Waste Management Measures

Waste Type	Waste Management Measures/Hierarchy		
	Avoid	Reuse/Recycle/Recovery	Treatment/Containment/Disposal
Construction			
Excavated Material	Design construction works to avoid excess excavation where possible	Excavated material would, wherever possible, be re-used on site. If this is not possible, the excavated material may be able to be reused as fill in another location. Topsoil would be reused in revegetation and rehabilitation of cleared areas.	Residue to appropriate DECCW approved clean fill landfill.
Vegetation Matter	Minimise the amount of clearing	Millable timber would be removed by DI&I as part of acquisition agreement with NSC. Remaining vegetative matter would be mulched and reused on-site. If this is not possible, the mulch would be used across the LGA for local revegetation works. Logs and tree limbs suitable for habitat and or fauna refuge would be collected during clearing and placed in a location identified as suitable.	Residue disposal to NWMF. Some material may be burnt on site.
Construction Waste	Construction materials would be sourced and ordered in appropriate quantities.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility.	Residue disposal to NWMF.
Miscellaneous Waste	Materials would be sourced and ordered in appropriate quantities.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility.	Residue disposal to NWMF.
Liquid Waste	Materials would be sourced and ordered in appropriate quantities. Dewatering would be minimised.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility. Dewatering water would be discharged locally providing it is adequate distance from waterways.	Residue disposal to NWMF. Human waste would be discharged to Bowraville sewage treatment plant.
Operation			
General Operation Wastes	Materials would be sourced and ordered in appropriate quantities	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility.	Residue disposal to NWMF.
Liquid Waste	Materials would be	Recyclable and non-recyclable	Residue disposal to

Waste Type	Waste Management Measures/Hierarchy		
	Avoid	Reuse/Recycle/Recovery	Treatment/Containment/Disposal
	sourced and ordered in appropriate quantities. Dewatering would be minimised.	materials would be segregated and transported to an appropriate recycling or waste management facility.	NVMF. Sewage would be discharged to a licensed sewage treatment plant.

18 Hazards and Risks

18.1 Introduction

This Chapter identifies and assess potential hazards and risks from the construction and operation of the Proposal on the local community and the surrounding environment.

Table 18-1 outlines the Director-General's and other statutory authority requirements and where they have been addressed.

Table 18-1 Statutory Requirements

Statutory Authority	EIS Requirements	Where Addressed
Director-General's requirements (DoP)	◗ Likelihood of soil contamination arising from the development or activity. ◗ Any hazards arising from the development activity. ◗ Analysis of construction impacts including: potential site rehabilitation measures.	Sections 18.2 - 18.4.
Department of Environment, Climate Change and Water (DECCW) (formerly DECC)	*Soils and Contamination*, baseline conditions, assess impacts and describe management and mitigation measures.	Chapter 18.2.3 and 8.

18.2 Existing Conditions

18.2.1 Bushfire Hazard

The study area, particularly within the Bowra Creek catchment and beyond within the Viewmont State Forest is considered to be bushfire prone land and represents an environmental hazard to residents within close proximity to the vegetation.

18.2.2 Flooding

The Nambucca River, South Creek and Bowra Creek frequently experience flooding after heavy rainfall events. Flood peaks within the Nambucca River can reach up to 2,430 m3/s. Given the propensity for flooding, only limited rural infrastructure exists within each respective floodplain.

18.2.3 Acid Sulfate Soils/ Contaminated Land

Given the general elevation and the soil types within the study area, no acid sulfate soils were identified within the study area. As the study area is primarily used for agricultural and forestry purposes. The agricultural purposes are predominately beef and dairy cattle.

18.3 Impact Assessment

18.3.1 Environmental Hazards/ Risks

Bushfire

The land use of the surrounding area is predominantly agriculture (i.e. grazing and cropping), the upper part of the Bowra Creek catchment is heavily vegetated. Hence, bushfires are considered to be a risk. NSC bushfire prone mapping for the area identifies the surrounding area as being bushfire prone land.

There are no planned activities that would significantly increase bushfire risk. Wherever possible, timber would be removed and sold as commercial, millable timber whilst non-commercial timber would be re-used as habitat or mulch. Any burning of waste timber would be dependant upon the quantities, location and practical alternatives, under a strict fire management plan.

Flooding

There is the risk of transport of additional sediment downstream from disturbed sites during flood events. The risk would be exacerbated at times of heavy rainfall and river/ creek flows.

Hence, careful management during the construction phase would be required to ensure that soils are exposed for the shortest time practical and no materials are stockpiled within the influence of flooding.

Contaminated Land

GHD identified the following past and current activities as having occurred on or adjacent to the site as having the potential to contribute to on-site soil and groundwater contamination:

- Fill material used in the construction of roads and residential dwellings;
- Previous and current agricultural activities;
- Potential asbestos bearing materials and lead-based paint in dwellings; and
- Potential indiscriminate illegal dumping around Monitoring Bore 7 (within Lot 1941, DP 829142). Further discussion on this issue is contained in Chapter 8.

Dust

The Proposal would implement particulate and gas / vapour exposure standards and procedures that would apply to dust, fibres, mist and fume (i.e. particulates), and gas and vapour exposures in the workplace (with emphasis on inhalation as the primary route of exposure).

The standards and procedures would cover, amongst other things, evaluation of particulate and gas / vapour hazards, and development of a control program to ensure that employees, contractors and the community would not suffer adverse health effects from particulates or gas / vapours, either used or generated by the Proposal.

Where required, the dust control program would include engineering controls and use of respiratory protection devices.

Health risks are expected to be low. Dust from earthmoving machinery would be controlled by water trucks. The nearest residences are within a kilometre of the site, and there is the

potential for these to be affected by dust during construction or operation (refer to Chapter 7 – Air Quality and Climate).

Noise

All equipment (both fixed and mobile) would comply with the relevant Australian Standard in regard to design and operating noise levels.

The Proposal would implement hearing conservation standards and procedures during construction and operation to ensure that employees and contractors would not suffer adverse health effects from noise generated in the workplace.

These standards and procedures cover, amongst other things, the identification and evaluation of occupational noise hazards and development of noise control programs to minimise noise levels and protect employees and contractors from adverse exposure. Where required, the noise control programs would include use of hearing protection devices.

There is the potential for the nearest residences to be affected by noise during construction and operation (refer to Chapter 12 – Noise and Vibration).

Pests

The Proposal is not expected to lead to an increase in the number of pests during construction or as a result of operation. Waste would be managed and removed from site periodically so that the potential for pests and vermin is minimised.

Weeds

There is potential for the spread of declared weeds from construction activities and vegetation clearance. There is also potential for weed invasion, particularly proliferation of Giant Parramatta Grass, around the edges of newly created banks of the storage.

The potential for the spread of weeds would be minimised by adherence to a routine weed management(refer to Chapter 9 – Flora and Fauna), which would be prepared prior to the commencement of any construction or clearing activities.

Chemicals

The chemicals used during the construction and operation phases would be relatively benign. Fuel (predominantly diesel), lubricants, oils, minor quantities of solvents, degreasers and domestic cleaning agents would form the majority of chemicals on site.

All hydrocarbons would be stored and handled in accordance with Australian Standard 1940:2004 *The storage and handling of combustible and flammable liquids*.

In the event of leaks or spills, chemical storage areas would be suitably bunded and constructed to minimise the potential for leaks to cause environmental harm. All chemicals would be stored, handled and used according to provisions in their MSDS. The health risk presented by these chemicals is relatively low (refer to Chapter 17 – Waste Management).

Blue Green Algae

The major risks to water quality from the storage appear to be the potential for bluegreen algal growth during extended warm dry weather conditions, exacerbated by nutrient runoff from farmland and the potential for elevated suspended solids and colour from dispersive soils found during construction of the storage. Mitigation measures such as dosing dispersive soils with

gypsum during construction may help alleviate the impact on water quality from any dispersive soils found in the catchment.

Deep-water storages can also suffer from inorganic complexes that can prove difficult to break immediately following a late winter inversion if destratification measures to prevent this from occurring are not effectively implemented (refer to Chapter 10).

18.3.2 Dam Break Modelling

A dam break and flood routing model (FLDWAV) has been used to determine impacts on downstream properties in the event that the storage experiences failure. The modes of failure evaluated are piping for the Sunny Day, 100-year ARI event and PMF flood events.

Piping failure generally results from a weakness in the dam or foundation, such as where structures pass through it, or where it interfaces with the natural surface. The breach grows from the point of failure outwards as the dam erodes. The rate at which this occurs is dependent on the geomechanical properties of the dam. Piping can occur in any weather conditions.

General Assumptions

A number of assumptions were made with respect to the dam break modelling including; the water level in the storage at the commencement of the flood was assumed to be at the FSL and for the piping breach, the centre elevation of the breach occurs 0.3 m below the peak water level.

Breach Parameters

Breach parameters (breach time and breach width) were estimated using various empirical methods.

Table 18-2 below summarises the breach parameters for the scenarios simulated.

Table 18-2 Breach Parameters

Parameter	Dam Break Scenario		
	Sunny Day	100-yr ARI	PMF
Breach Mechanism		**Piping failure**	
Storage Elevation when Breach Commences (m AHD)	38.10	38.76	39.65
Breach time (min)	36	37	38
Final breach width (m)	50	52	55
Breach side slopes (V:H)	1:0.9	1:0.9	1:0.9

FLDWAV Peak Flows

FLDWAV computes the breach outflow hydrograph based on the breach parameters and a description of the reservoir. The peak flows from FLDWAV are tabulated in Table 18-3.

Table 18-3 Breach Peak Flows

Scenario	Peak Flow (m3/s)
Sunny Day Dam Break	4,420
100-yr ARI Dam Break	4,770
PMF Dam Break	5,150

Flood Routing Validation

To confirm the correct operation of the FLDWAV models, inflow hydrographs were routed in both the RAFTS and FLDWAV models. These two models differ in their methods of configuring dam areas capacity data and discharge rating curves. The peak flows were compared, with results presented in Table 18-4 below.

Table 18-4 FLDWAV Model Validations

Scenario	RAFTS (m3/s)	FLDWAV (m3/s)
100-yr	15.6	16.8
PMF	57.6	55.9

The results show favourable agreement, lending confidence to the configuration of the models.

Flood Mapping

Flood maps were produced based on the results from MIKE 11, which allocates a flood level to each cross-section along the creek. Flood extents were mapped approximately 10 km from the dam, to a position pass the junction of Wilson Road and Hillview Drive. Good quality contour data is not available beyond this point. Since Nambucca River has a relatively flat recession downstream of the storage, it is expected that the dam break wave would recede by this point. Furthermore, we find that the PMF with dam break flood levels are of similar magnitude to the PMF without dam break flood levels at this point. Figure 18-1 illustrates the flood mapping for the dam break.

1.4.1 Consequence Category Assessment

The Sunny Day Consequence Category and Flood Consequence Category for the Proposal have been assessed in compliance with the NSW Dam Safety Committee's Data Sheet DSC13(b) (March 2002) and the ANCOLD Guidelines on Assessment of the Consequences of Dam Failure (May 2000).

It would be noted that the consequence category assessments are a best estimate based on the information available. No survey on house levels in and around Bowraville has been provided, and as such the flood inundation depth at these locations within the flood zone is unknown. For the purpose of this consequence category assessment, it is assumed that all dwellings within the flood zone are inundated (i.e. flood depths greater than 0.3m).

BOWRAVILLE
Upper Bowra Creek
Nambucca River
Bowra Creek
Nelsons Creek
Nambucca River
Lower Bowra Creek Road
Bowra Creek Road
Nelsons Lane
Irvines Road
Rodeo Drive
Wilson Road
Allards Road
Bowra Creek Road
Nelsons Creek Road
Rainforest Trail
Coral Tree Trail
Old Bowra Road
Bowra Creek Road
Nambucca River Bowra Road
Nambucca River Bowra Road
Bowra Creek Road
Bowra Creek Road
Bowra Creek

In accordance with ANCOLD (May 2000), this consequence assessment is regarded as an 'Initial Assessment' of the consequences of dam failure.

Sunny Day Consequence Category

Population at Risk

Based on the flood extent map, no dwellings within Bowraville itself are inundated in a sunny day dam break failure of the dam. However, there are houses located to the north of the town that lie within the flood zone. Approximately six houses on the northern side of Bellingen Road are affected, as are two houses neighbouring Rodeo Drive northwest of the racecourse.

Similarly, a house off a dirt track from Valla Road and another has been identified as in the flood zone. A total of nine houses are affected by the sunny day dam break scenarios. Assuming three persons per dwelling, the non-itinerant population at risk (PAR) is 27 persons.

Itinerant populations are at risk in the form of traffic on the affected roads and bridges. A small section of Rodeo Drive is inundated by the sunny day dam failure flood, as is part of Valla Road. While multiple itinerants may be exposed at any one time, they are typically present for only a short period of time. For the purposes of this exercise, it has been assumed that the contribution of itinerants is equivalent to one vehicle on each road, each carrying two passengers. This is considered reasonable due to the short length of the roads inundated, and the fact that these country roads are expected to have low traffic flows.

The itinerant PAR is therefore 4 persons.

Whilst every effort has been made to minimise impacts as a result of a potential dam break through the design of the storage and associated infrastructure, the total population at risk is 31.

Severity of Damage and Loss

The Severity of Damage and Loss has been assessed using the severity of damage and losses table from the ANCOLD (2000). The assessed 'Severity of Damage and Loss' for dam break failure of the Proposal is likely to be 'Medium'.

Sunny Day Consequence Category Assessment

With the PAR assessed to be in the category of '10 to 100', and the Severity of Damage and Loss estimated to be Medium, the sunny day consequence category of the Proposal is 'High C'.

Flood Consequence Category

Population at Risk

Incremental Population at Risk

In terms of the incremental consequences of dam failure, the 100 year ARI flood on the dam catchment is the most critical flood scenario to be considered in the dam break study. For this scenario, an additional nine dwellings are affected by the flood event with dam failure compared to the flood event without failure.

Assuming three residents per dwelling, the incremental PAR for non-itinerants is thus assessed to be approximately 27 (with dam failure).

As was the case for the Sunny Day Consequence Category, itinerant populations are at risk in the form of traffic on the affected roads. Bellingen Road is not inundated for the 100 year ARI

flood event, but is inundated in the 100 year ARI flood with dam break event. Assuming again that the contribution of itinerants on this road is the equivalent of one car with two passengers, this gives an itinerant PAR of 2.

The total incremental population at risk is 29 persons.

Total Population at Risk

The PMF with dam break flood scenario with and without dam break produced the largest flood zone downstream of the dam. In this dam break event the flood zone infiltrates Bowraville township in the northeast and southeast areas of the town. It would be noted that the flood extent is similar for both the PMF flood event with and without dam break, and hence there is no incremental PAR for this flood scenario.

Population at risk within the flood extents as shown in Figure D3 was assessed as far as the junction between Wilson Road and Hillview Drive, after which there is no available contour data to map the flood. In total, one hundred and eighteen (118) houses are estimated to be affected by the PMF with (and without) dam failure flood scenario. Assuming three persons per dwelling, the non-itinerant PAR is 354 persons.

The service station on Carbin Street is also within the flood zone. The contribution to PAR from the service station is 2 persons.

Numerous streets and roads are fully or partially affected by the flood event. The roads potentially inundated are: Bellingen Road, Valla Road, High Street, Rodeo Drive, Grassy Road, Park Street, Bowra Street, Wouldiam Street, Wilson Road, Conen Street, Alberta Street, River Street, Cook Street and Carbin Street.

Assuming that the itinerants at risk consist of one vehicle per road or street, with two passengers per vehicle the itinerant PAR is 28 persons.

The total population at risk in the PMF with dam break scenario is therefore 384.

Severity of Damage and Loss

As for the Sunny Day scenario, the assessed Severity of Damage and Loss is 'Medium'.

Flood Consequence Category Assessment

In terms of incremental consequences, for a PAR in the category of '10 to 100' and a 'Medium' severity of damage and loss, the flood consequence category of the storage is assessed to be 'High C'.

In terms of total consequences, for a PAR within the range of '100 to 1000' and a 'Medium' severity of damage and loss, the flood consequence category is assessed to be 'High A'.

Summary

An 'Initial Assessment' of the consequences of dam failure has been made in accordance with ANCOLD and NSW Dam Safety Committee requirements.

The Sunny Day Consequence Category for the storage has been assessed as 'High C'. The Flood Consequence Category has been assessed in terms of incremental and total population at risk. To assess incremental PAR, the 100 year ARI flood event was found to be the most critical. In terms of total PAR, the PMF event was found to be the most critical. For the PMF event, little to no difference was noted between the flood extent with and without dam break

events. This means the incremental effects as a result of the dam failure in this event are almost negligible.

In terms of incremental consequences, the Flood Consequence Category has been assessed as 'High C'. If the total consequences are considered, the Flood Consequence Category has been assessed as 'High A'. A summary of the population at risk for each of the flood events is provided in Table 18-5.

Table 18-5 Summary of Population at Risk

Flood Event	Inundated Houses	Non-Itinerant PAR	Inundated Roads	Itinerant PAR	Total PAR	Incremental PAR
Sunny Day	9	27	2	4	31	NA
100 Year ARI (No Dam break)	12	36	3	6	42	NA
100 Year ARI (Dam break)	21	63	4	8	71	29
PMF (No Dam break)	118	354	15*	28	384	NA
PMF (Dam break)	118	354	15*	28	384	0

* includes service station

18.3.3 Construction and Operation Safety Issues

The key hazards identified with the construction and operation phase are discussed below, along with appropriate prevention, detection and protection measures. The type of traffic predicted to occur during the construction and operational phases would pose negligible risk to any nearby bridge or road structures.

Equipment

Construction vehicles and equipment would be operated within the manufacturer's specifications. All vehicles and equipment would be maintained and serviced on a regular basis. Records of maintenance and servicing would be retained on-site for the duration of the construction phase.

Machinery and equipment operators would be trained and carry their current licences, where necessary. The health risk presented by equipment or machinery operation is considered low.

The key hazards identified with the Proposal are also shown below, along with appropriate prevention, detection and protection measures.

Vehicle Collision and Driving Conditions

Vehicles on the construction site are likely to include excavators, scrapers, front-end loaders, graders, rollers, water trucks, dump trucks and light vehicles (four-wheel drives) that operate on roads and access roads around the Proposal. Collisions between these have the potential to cause serious injury to operators, passengers and other site personnel.

Construction workers operating vehicles on-site would be trained and licensed, so that these vehicles are driven in a safe and appropriate manner. Speed control (signage), driving to conditions, and prescribed driving etiquette on the site would be used to control the risk. All vehicles would be fitted with radios for two-way communication.

Watering of roads and access areas would be undertaken regularly to suppress dust and improve visibility.

The potential for injury from vehicles on the construction site is confined to construction personnel and animals, and the risk is considered minor.

Personnel Interaction with Machinery

Personnel may be at risk of interacting with construction machinery, parts from vehicles and earth moving equipment, resulting in the potential for serious injury. The hazards from interaction with machinery may occur during construction and the movement of heavy equipment.

Although the potential for injury is moderate, strict adherence to the Proposal's workplace health and safety rules and established safety systems would reduce the likelihood of occurrence.

Fuel Storage (Mobile and Static)

Fuel storage on-site would be predominantly diesel, which presents a relatively low combustion risk and a moderate environmental risk. Ignition sources would be controlled to avoid fire involving bulk fuel oil. Fire fighting facilities would be provided at fuel storage facilities.

All hydrocarbons would be stored and handled in accordance with AS 1940:2004 *The Storage and handling of flammable and combustible liquids*. Chemical storage areas would be suitably bunded and constructed to minimise the potential for leaks to cause environmental harm.

The hazard associated with the storage of fuel oil arises from leaks or failures in the system. To minimise the hazards associated with fuel oil leaking during tanker unloading, the following measures would be in place:

- a program of regular equipment inspection and testing would be continued to ensure reliable performance;
- operators would continue to be trained in the safe operation of the system and emergency procedures in the event of fuel oil leakage;
- spill containment equipment would be available at the unloading pad for use in the event of spillage;
- a sump would be provided to collect any spillage and allow recovery;
- ignition sources would be strictly controlled and limited to avoid a fire;
- appropriate fire fighting materials and equipment would be available to suppress fires; and

- an approved fire protection system would be installed around new hydrocarbon storage areas.

The following measures would be taken to minimise the potential for the leakage of fuel oil from storage tanks:

- adequate bunding would be constructed to contain spills, in accordance with AS 1940:2004;
- tank level indicators would be installed on fuel oil tanks for monitoring of fuel oil levels;
- maintenance of fuel oil tanks would be undertaken, to ensure safe and effective operation of all components; and
- tanks would be designed in accordance with AS 1692: 2006 *steel tanks for flammable and combustible liquids* to minimise the potential for failure of the diesel storage vessel.

Standard operating procedures for the storage, containment, disposal and spill response for potentially hazardous materials would be developed. The use of AS 1940:2004 for the management of fuel storage (bunding and containment) would reduce this risk to a low level (refer to Chapter 12 – Waste Management).

Blasting and Misfires

Blasting creates a number of potential risks such as dust, noise, vibration and fly-rock and air-blast effects. Fly-rock and air-blast effects can cause serious personal injury if not properly controlled and therefore create a high risk to the workers.

Mitigation measures include the use of blasting experts to undertake safe blast design, control of access (including temporary mine site road closure) and evacuation warnings before blasting.

Personnel in the vicinity of a blast would continue to wear PPE and all personnel would observe safe distances during blasting activities.

Proper stemming would be used in the preparation of charges and appropriate charge ratios would be used to limit the amount of fly rock produced by a blast. Blasting operations would continue to be carried out by an explosive contractor, which has an established record of operation in the industry and adherence to the Australian Explosives Manufacturer Safety Committee (AEMSC) Code of Practice.

Blasting misfires include incomplete detonation of the blast. This may reduce or confine the blast impact, and may pose safety issues to personnel re-entering the area of blast misfires. The training and management of the blast crew would be required to ensure appropriate knowledge and skill by personnel involved in blasting activities.

Safety procedures would be strictly adhered to on-site to limit the probability of the hazard occurring.

High Voltage Exposure

Powerlines affected by the Proposal would include extensions to the feeder north and south of Nambucca River and to the west of South Creek. This work would be undertaken by Country Energy concurrently with the Proposal. Specialist electrical engineers would undertake this using approved codes of practice and procedures.

Extensions to electricity infrastructure, electricity use from lighting and the electrical operation of infrastructure would require the use of potentially lethal levels of voltage and amperage.

There would be specific and detailed standard operating procedures implemented that deal with high voltage. The residual high risk can be managed by ensuring the preventative controls are well implemented and monitored.

Working at Height and Falling Objects

There would be instances where workers are required to work at height during the construction phase (e.g. buildings / infrastructure) although these would be minimised. However, where working at heights is unavoidable, Safe Operating Procedures for working at height would be used to control this risk.

Mandatory PPE on a construction site that protects against objects falling from height includes steel capped boots and safety hats (both are worn at all times). Fall of persons would be controlled through appropriate elevated work platforms and the proper use of harnesses.

The residual risk is "moderate" with these controls, as safety statistics during construction activities indicate that injuries caused from falling objects and falls do contribute significantly to work-related injuries.

During operations, there would also be instances where operators are required to work at height during maintenance or repair duties. Safe Operating Procedures for working at height would continue to be used to control this risk.

The residual hazard is still "moderate", as safety statistics at operating sites indicate that injuries caused from falling objects and falls do contribute significantly to work-related injuries. Hence the preventative controls must be strictly enforced.

Transportation

Licensed transporters operating in compliance with the Australian Dangerous Goods Code would undertake the transport of dangerous goods to the construction site.

Off-site transport accidents have the potential to occur, but the risk is low. Most of the transport occurs along major roadways. The increased exposure of the public to this hazard due to the dam construction is low and the frequency of such an event occurring is low. Therefore, this event is not a likely scenario for the Proposal.

The potential for a diesel transport accident to occur is low. Most of the road tanker transport occurs along major roads. An accident involving a road tanker would most likely require a second vehicle to collide with the tanker. Tanker drivers are trained to such a level, and are sufficiently experienced that single vehicle accidents do not regularly occur.

The increased exposure of the public to a diesel transport hazard is low and the frequency of such an event occurring is low. Therefore, this event is not a likely scenario for the Proposal.

Biological Hazards

There are potentially dangerous fauna, such as snakes and spiders, likely to be present in the study area. However, these species are not likely to cause a high risk because of their behaviours, populations or potential toxicities.

Standard practices under workplace health and safety guidelines would be sufficient to minimise the risk of snake bite and other interactions with biological hazards such as spiders and ticks.

Security

The construction area would need to be enclosed with suitable fencing. Fencing would protect selected areas with high risk of a security breach or unauthorised public access.

Prior to being given access to the construction site, visitors would complete mandatory registration and an environmental, health and safety induction. The scope of induction would reflect those areas of the construction site that the visitor would be permitted access.

Decommissioning Phase

A decommissioning date for the Proposal has not been determined at this stage. The storage would be an integral part of the NSC water supply strategy and would be maintained to meet dam safety requirements. A possible decommissioning date is likely to be too far in the future to allow effective planning for decommissioning to occur at this point in time.

When this does occur, consideration to matters such as potential impacts on terrestrial and aquatic ecology and surrounding land use, and the resultant changed hydrology would need to occur. It is not practical to identify the hazards and risks that could be relevant at the decommissioning phase because the decommissioning process and timing has not been determined.

Public Liability of Infrastructure

For the construction phase public liability and protection of infrastructure would be managed by the contractor with closure of the area to the public, so there is no public access to the construction site.

Protection of infrastructure would be maintained by ensuring the contractor has identified all assets and undertakes construction in a way that does not damage this infrastructure or cause a reduction in service provided by the dam and associated infrastructure.

A safety risk assessment would be undertaken of the Proposal to identify areas of high risk to public safety. Exclusion zones would be developed to prevent public access to high risk areas, with fences and signs erected to delineate such areas. For land that surrounds the inundation area, such as that leased back to landholders, public liability for access onto that land would be with the landholder.

18.3.4 Seismic Hazard Assessment

A seismic hazard assessment of the Proposal was undertaken by the Seismology Research Centre (SRC), a division of Environmental Systems & Services Pty Ltd (ES&S).

This was a probabilistic hazard assessment which employs a seismotectonic model that considers the seismicity and geology of the area in order to estimate seismic activity rates. The seismotectonic model allows for calculations of expected ground motion recurrence at the site, including peak ground acceleration (PGA) and response spectra, the results of which are included herein. Seismotectonic source contributions are presented to indicate the relative significance of each source with respect to PGA. Also included are peak ground velocity (PGV) and modified Mercalli intensity (MMI) recurrence estimates.

All calculations have been performed assuming the site is situated on bedrock geology and all results are for horizontal motion. Response spectra have been produced for 5% damping. Note that the attenuation functions used for the different calculations are not necessarily consistent.

Spectral, PGA and PGV calculations are produced using the attenuation functions of Chiou & Youngs (2008), while MMI calculations have been performed using attenuation functions published by Gaull, Michael-Leiba and Rynn (1990).

Results

The PGA for the storage has been calculated as being approximately 0.019 g for a return period of around 500 years (10% chance of exceedence in 50 years) when considering earthquakes of Richter magnitude ML 4 and above for bedrock (assuming a Vs30 value of 2,000 m/sec). This value is below average by Australian Standards. In comparison, Newcastle in New South Wales has a PGA of approximately 0.11 g, while Wellington, New Zealand, and San Francisco, California, have a PGA of 0.50 g.

The Proposal is expected to experience earthquake intensities of MMI 3 vibrations which are strong enough to be felt approximately every 29 years. Intensities of MMI 6 when standard housing experiences damage are expected to occur approximately once every 1,260 years.

18.4 Mitigation Measures

18.4.1 Human Health

To minimise the potential human health impacts associated with construction and operation of the proposed development, the following mitigation measures would be implemented:

- A site Occupational Health and Safety Plan (OHS Plan) would be developed by the construction contractor prior to the commencement of works at the proposed development area. The OHS Plan would be developed to satisfy WorkCover requirements and would include the following information:
  - A safe system of work (work method procedures) for both construction and operation phases to ensure the health and safety of site personnel;
  - A contingency plan and emergency procedures to be adopted in situations which might arise and are not covered by normal OHS procedures; and
  - A list of site supervisors identifying their responsibilities with regard to OHS.
- Minimising operational fuel and chemical storage on the site. Where possible, fuels and chemicals would be transported to the site when required;

18.4.2 Environmental

- Prepare a Bushfire Management Plan for the Bowra Creek Catchment.
- It is proposed that further site investigations be undertaken during the detailed design phase, within Lot 1941, DP 829142 around Monitoring Bore 7. Agricultural land, access roads, areas of landfilling and soil adjacent to dwellings disturbed during the construction of the pipeline and borefields would also be assessed. The Environmental Management Plan (EMP) for the Proposal would detail appropriate procedures for the handling, stockpiling and assessment of potentially contaminated fill and materials during the works.

19 Social and Economic

19.1 Introduction

This Chapter provides an assessment of the potential social and economic impacts and benefits of the Proposal, including potential changes resulting from the construction and operation of the Proposal. Possible mitigation measures are also identified to maximise the benefits and minimise the impacts of the proposal for the local and regional community.

Table 19-1 outlines the Director-General's requirements and where they have been addressed in the Chapter.

Table 19-1 Statutory Requirements

Statutory Authority	EIS Requirements	Where Addressed
Director-General's requirements (DoP)	◗ The social and economic impact of the development or activity.	Sections 19.4 and 19.5.

19.2 Methodology

This assessment has been based on quantitative and qualitative analysis of existing community characteristics, specifically:

- an analysis of the existing socio-economic environment, including an assessment of key population and demographic characteristics of the affected communities, an analysis of local social infrastructure (including housing and facilities), a review of existing housing and accommodation factors, and assessment of employment and local business;
- assessment of the potential socio-economic impacts of the construction and operation of the Proposal including effects on local and regional communities, social infrastructure, community values, and workforce; and
- identification of potential mitigation strategies to maximise the community benefits and minimise any adverse socio-economic impacts.

19.3 Existing Conditions

19.3.1 Study Area

The Proposal is located within the Nambucca Local Government Area (LGA). The LGA covers an area of approximately 1,400 km^2 and includes ten towns and villages including Nambucca Heads, Macksville, Bowraville, Valla Beach, Scotts Head, Eungai Creek, Eungai Rail, Taylors Arm, Warrell Creek and Donnellyville. Features of the LGA include fertile agricultural lands, coastal plains, beaches, popular coastal towns, in addition to national parks and state forests.

The Proposal is located in a small upper valley within fringing ranges on the northern margin of the Nambucca River catchment. The Proposal is situated two kilometres north of the town of Bowraville and 1.5 km north-east of the Nambucca River.

Bowraville is located approximately 14 kilometres north of Macksville and acts as a service and shopping centre for the areas of Missabotti, Argents Hill, North Arm, Buccrabendinni, and South Creek (NSC, 2008).

The Proposal would inundate the upper catchment of Bowra Creek, a small southwest draining tributary of the Nambucca River, with a total catchment of around eight square kilometres. The majority of the off-river storage embankment would be located in cleared grazing land, while the inundation area occurs within the Viewmont State Forest, which is well forested.

19.3.2 Population Characteristics and Settlement

Population

The Proposal is located to the north of Bowraville within the Nambucca LGA and has a population of 17,974 persons (including visitors) and a total number of households of 8,594 (ABS, 2006).

Table 19-2 shows the population of the Nambucca LGA between 1996 and 2006.

Table 19-2 Population Nambucca LGA

	1996 Census	2001 Census	2006 Census	Change 1996 to 2006	Change 2001 to 2006
Nambucca LGA	17,610	17,718	17,974	0.6%	1.4%

Source ABS Census 2006 , 2001 Place of Enumeration

Age Profile

During the 2006 census, 13 percent of the LGAs population was aged over 65 years, which is slightly lower than the state average of 14 percent.

Nambucca LGA has a median age of 46 years compared to the NSW state average of 37.

Nambucca LGA is similar to many coastal areas, with lower proportions of younger people (15-34 years) and higher proportions of older people (over 45 years). This reflects population trends such as young people leaving the area to seek education opportunities or to find work, general population ageing, and the inflow of older "sea-changers" who seek the coastal lifestyle and more affordable retirement options. Nearly half the population in Nambucca LGA is aged over 45 years old.

Household Size

The average household size within Nambucca LGA is 2.1 persons, which is below the Coffs Harbour LGA and NSW averages of 2.6 and 2.7, respectively. This low occupancy is a reflection of an older age profile for the LGA, with nearly half the population over 45 years old. The LGA has a high-unoccupied private dwelling rate of 11.8 percent in comparison to NSW, which stands at 8.9 percent (NSC, 2008).

Accommodation and Housing

Table 19-3 shows a higher than average incidence of home ownership across the LGA compared with the state average. This is likely to be as a result of its rural and coastal character with many people owning and living in rural and coastal properties. The proportion of people renting houses is correspondingly lower than the state average.

Table 19-3 Tenure Type

Tenure Type	Nambucca LGA	Bowraville	Macksville	Nambucca Heads	NSW
Fully owned	46%	42%	46%	44%	35%
Being purchased	24%	27%	23%	15%	32%
Rented	26%	29%	26%	35%	30%
Other	4%	1%	5%	5%	4%

Source: ABS Census 2006

Both temporary and permanent accommodation is available throughout the study area. As shown in Table 19-4, temporary accommodation comes in the form of caravan parks, and backpacker's accommodation. Hotels and motels are also available.

Table 19-4 Accommodation Types

Accommodation Type	Nambucca LGA	Bowraville	Macksville	Nambucca Heads
Separate house	5,954	2,278	857	1,717
Semi-detached, row or terrace house, townhouse etc. with:	254	64	0	188
Flat, unit or apartment:	567	47	7	476
Caravan, cabin, houseboat	337	4	3	229
Improvised home, tent, sleepers out	21	0	0	5
House or flat attached to a shop, office	23	3	24	7
Other	11	0	0	8

Source: ABS Census 2006

Nambucca LGA's dwelling growth rate has exceeded that of population. The high proportion of unoccupied dwellings in some urban centres is significant (e.g. 32% in Scotts Head), which reflects the high proportion of holiday homes in the coastal settlements.

Historical and current typical residential bills for water supply in the Nambucca LGA are as follows:

- Prior to 1991-1992 there were no residential meters, therefore only access charge and usage at no cost.
- 1992 to 1995 access charge and daily kl allowance. Excess used over allowance was charged.
- 1995 to present access charge and full user pays. Price went from 65 cents per kilolitre to 90 cents to $1.00 to $1.10 to $1.25 and is presently $1.37.

19.3.3 Future Population Growth

Regional context

The *Mid North Coast Regional Strategy* (MNCRS) estimates that the mid north coast could experience a potential population increase of 91,000 between 2006 and 2031. This would take the population from 333,400 to 424,400, an increase of more than 27 percent (Department of Planning, 2007).

According to the MNCRS the average annual growth rate is expected to be 1 percent over the next 25 years, which would be among the highest regional growth rates in NSW (Department of Planning, 2007).

This growth is predicted to increase the demand on the centralised water supply by about 1.7 percent per annum (NSC, 2001 to 2004).

Local context

Between 1991 and 1996 the average population growth rate of the LGA was 1.1 percent per annum. Between 1996 and 2001 the average population growth rate declined to 0.1 percent, with some years recording a population loss.

Since 2001, growth in the LGA has continued to slow, with an annual average population growth at 0.2 percent. The annual average growth for the last 25 years has been 1.7 percent.

The *Nambucca LGA Structure Plan* (NSC, 2008) estimated the population in the Nambucca LGA would grow by approximately 2 percent per annum over the next 20 years. The Plan estimates by 2026 the population would grow to 26,593 persons (8697 additional persons from 2006).

The additional population would require construction of around 3,954 new dwellings, to cater for the new residents. The Structure Plan envisages that the increased population would be accommodated through:

- the consolidation of existing centres,
- infill development with increased residential densities and shop-top housing focused on existing town an neighbourhood centres,
- new land release areas, and
- new rural clusters and hamlets.

19.3.4 Future growth areas

The MNCRS identifies four Subregions of which Nambucca LGA is incorporated in the Coffs Coast Subregion. Within this Subregion 18,600 dwellings are projected, with the majority of growth occurring within the Coffs Harbour LGA.

The MNCRS as well as the *Nambucca LGA Structure Plan* (NSC, 2008) has identified a potential release area in Boggy–Cow Creek near Valla with a total land area of 574 ha. The site currently consists of undulating farmland dissected by the two creek lines. Much of the site is cleared farmland and enjoys expansive rural and sea views. This area is located near a proposed exit from the planned realigned upgraded Pacific Highway.

Areas of potential population growth within existing zoned urban areas were also identified and reviewed with the use of NSC planning documents and in conjunction with NSC's town planners.

The projected increase in population growth over the next forty years would result in an increase in demand for the existing urban water services. Table 19-5 shows the projected population that would be connected to the Nambucca and District Water Supply Scheme.

Table 19-5 Projected Growth in Population Serviced by Nambucca and District Water Supply Scheme

Location	2006	2011	2016	2021	2026	2036	2046	Growth %
Bowraville	992	1,009	1,031	1,036	1,036	1,036	1,036	0.1
Macksville	2,705	3,038	3,454	3,712	3,953	4,129	4,306	1.5
Nambucca Heads	5,984	6,368	6,848	7,140	7,385	7,875	8,366	1.0
Valla Beach	1,486	1,710	1,990	2,085	2,135	2,236	2,336	1.4
Scotts Head	804	1,148	1,579	2,043	2,200	2,461	2,677	5.8
Valla Urban Growth Area	0	0	0	1,089	2,178	3,921	3,921	-
Rural	1,069	1,164	1,297	1,417	1,486	1,499	1,512	1.0
Total Permanent Connected	13,040	14,438	16,199	18,523	20,374	23,160	24,151	2.1
Visitors (Peak)	6,354	6,869	7,383	7,562	7,659	7,852	8,045	0.7
Total Peak Connected	19,394	21,307	23,582	26,085	28,033	31,012	32,196	1.7
Unconnected	5,179	5,223	5,282	5,354	5,436	5,614	5,792	0.3

19.3.5 Economy

The *Nambucca LGA Structure Plan* (NSC, 2008) reported that the economy of Nambucca has experienced considerable levels of growth associated with residential development and real estate price growth.

The unemployment rate in 2005 was 14.8 percent, which was significantly higher than the NSW average of 5.3 percent. The total income earned during the same year was $145 million in the Nambucca LGA.

Nambucca LGA was ranked 7th in the state in the 2006 Census as being high socio-disadvantaged (Social –Economic Indexes for Areas, SEIFA, 2006). Low scores of the index (Nambucca LGA has a low score of 893) occur when an area has many low-income families and people with little training and in unskilled occupations. This means Nambucca LGA has a high level of disadvantage compared to other areas.

Labour Force Participation

Bowraville and the Nambucca LGA have historically experienced higher unemployment than NSW as a whole, with Bowraville experiencing extremely high levels of unemployment (refer to Table 19-6). This is also reflected in the number of persons employed.

Table 19-6 Labour Force Status

	Nambucca LGA	NSW
Employed, worked:	85%	94%
Unemployed	15%	6%
Total labour force (no.)	6,421	3,092,603

Employment by Industry

The tertiary (commerce based) sector is the most significant economic contributor in the LGA, accounting for 30.1 percent of employment. This was largely driven by the retail trade sector.

The quaternary (business and information services) sector (which is high value, high productivity industries) and the quinary (household based) sector are significant contributors to the Nambucca economy accounting for 24.8 and 19 percent of the employment.

Table 19-7 illustrates that the health care and social assistance sectors contributed the greatest employment in the LGA and Bowraville.

Table 19-7 Employment by Industry, 2006

	Nambucca LGA
Health care & social assistance	14%
Retail trade	14%
Accommodation & food services	9%
Education & training	9%
Construction	8%
Manufacturing	8%
Agriculture, forestry & fishing	7%
Public administration & safety	5%
Transport, postal & warehousing	4%
Professional, scientific & technical services	3%
Wholesale trade	2%
Financial & insurance services	2%
Administrative & support services	2%
Rental, hiring & real estate services	2%
Information media & telecommunications	1%
Arts & recreation services	1%
Electricity, gas, water & waste services	1%
Mining	0%

Income

Households in the Nambucca LGA and Bowraville had lower median incomes compared to NSW (refer to Table 19-8). Median Household income was almost half that of NSW as a whole. Households in the Bowraville urban centre had slightly lower median weekly incomes than the LGA as a whole, at $516.

Table 19-8 Median individual, family and household income, 2006

	Nambucca	NSW
Median individual income ($/weekly)	296	461
Median family income ($/weekly)	642	1,181
Median household income ($/weekly)	562	1,036

19.3.6 Economic Growth

The *Mid North Coast Regional Strategy* (MNCRS) estimates that population increases in the mid north coast would create a demand for additional employment opportunities. It is expected an additional 47 000 jobs would need to be created, of which 75 percent of these jobs would be needed to meet demands arising from the housing and servicing of additional population and 25 percent of jobs would need to be created in new industries or services supplying markets outside of the mid north coast. The Strategy identifies an additional 83 hectares of employment lands are needed in the Coffs Coast Sub-region. The majority of this growth is likely to occur in the Coffs Harbour LGA.

The *Nambucca LGA Structure Plan* (NSC, 2008) estimated 6,000 to 7,000 new jobs would be created by 2026. The Plan estimates this would occur through the following processes.

- The take up of existing employment-zoned land;
- New release areas to accommodate heavy industry and an inter-modal freight facility at Boggy/Cow Creek in the vicinity of the realigned Pacific Highway, just north of Nambucca Heads;
- Employment growth within the major centres (Macksville, Nambucca Heads, Scotts Head, Valla Beach, Bowraville and the Boggy & Cow Creek future urban area); and
- Increased opportunities for tourist development in and around the existing centres, with additional attention to the development of 'Eco-tourism facilities', 'artisan live-work' areas and additional higher educational facilities.

19.3.7 Property Market Profile

The median house price in Nambucca in March 2005 was $279,000 (NSC, 2008). Since 2004, the median house prices in the LGA have declined by 6 percent. Median house prices in Bowraville are generally lower than that of the LGA. Prices declined between 1999-2000 and then increased slightly between 2000-2004, reaching approximately $175,000.

Research by Hill PDA (2005) with local agents regarding residential home values within the Nambucca LGA identified the following key points.

- Residential prices typically range from $200,000 to $400,000, however there are examples of over $1,000,000 for prime coastal properties;
- Sea changers and retirees are the predominant prospective buyers for residential property, who seek water views and easy access to the beach and services. It is the concept of a 'sea change' that has contributed to increasing residential prices. There is a high demand for properties within the vicinity of Valla Beach and Scotts Head – boutique type areas which would retain their village appeal.
- Properties located within walking distance to beaches and/or with water views have a very high selling price. Both Valla Beach and Scotts Head are achieving property values between $1.2- $1.25m;
- Lower prices are located mainly in Newville (Nambucca Heads). Significant levels of public housing have lead to some preconceptions about Nambucca which in turn can affect values;
- Bowraville also has some high priced properties due to the views of the mountains; and
- Properties with a land area ranging from 800m^2 to 1000 m^2 are selling for a minimum of $350,000.

19.3.8 Business activity

As stated previously, the study area has a high proportion of its workforce in the retail trade and health care and social assistance. However, traditionally agriculture, forestry and fishing had a relatively high workforce in the LGA.

Commercial lands within the Nambucca LGA exist at Nambucca Heads, Macksville, Scotts Head, Bowraville and Valla Beach. Nambucca Heads' main commercial area is located along Bowra Street and comprises a reported 5.2 ha, while Bowraville contains 1,500 m^2 of lettable commercial space.

NSC has pursued several successful initiatives to attract industry and people back into the LGA. Emerging and developing industries in the study area include macadamia processing, vehicle body manufacturing, bus manufacturing, agribusiness/timber processing, truck & trailer manufacturing, steel frame construction, building and construction, Nambucca valley oysters, aged care and retirement living, tourism, creative industries, food and cuisine (NSC, 2008).

19.3.9 Primary industry

Approximately 55% of land within the LGA is zoned as Rural under the *Nambucca Local Environmental Plan 1995*. The agricultural industry accounts for 6.9 percent of employment in 2006 with most of the agricultural land used for livestock and dairy production. Other agricultural activities in the LGA include macadamias, bananas, avocadoes and vegetables.

Forestry was identified as an emerging industry within the *Nambucca LGA Structure Plan* (NSC, 2008). Approximately 28,156 ha (or 18% of the LGA) of land in the LGA is State Forest, of which 205 ha of native forest was logged during 2004/2005 and approximately 122.2 ha of land was approved to be cleared for logging/forestry purposes. It would be noted that the proposal occurs within the Viewmont State Forest.

19.3.10 Recreational Environment

Nambucca LGA includes a wide range of sport, recreation and leisure facilities and clubs. There are 68 NSC owned park reserves and sporting facilities and 9 privately owned recreational facilities in the LGA (not including surf clubs) (NSC, 2004). These cater for local and regional communities, and include facilities providing organised sporting activities, as well as informal recreational and leisure opportunities.

Some of the key sport and recreation facilities in the Nambucca LGA include:

- Numerous parks which cater for the informal recreational needs of local residents;
- Sporting fields, including E J Biffin Playing Fields and Coronation Park, Nambucca Heads,
- Formal sport facilities, including Bowraville Racecourse and Bowraville Sport and Recreation Club; and
- Nambucca Indoor Sports Centre.

Recreational fishing is an important past time for many residents in the LGA. Key fishing locations include Nambucca River, Warrell Creek and Deep Creek, which is supported by multiple launching ramps and trailer parking facilities. Fishing clubs in the area include the Nambucca Heads Off-Shore Fishing Club and the Macksville - Scotts Head Fishing Club.

Located to the south of the proposal is the Bowraville golf course, which forms the western edge of the town and contains 2 squash courts, 2 bowling greens and a 9 hole golf course (NSC, 2004).

The Bowraville racecourse is located across the Nambucca River to the east of the town centre approximately 2 kms south of the proposal. The race course contains a licensed horse race course, horse stalls, 8 overnight stables and day stalls, various other facilities and a caretakers residence.

There are other public parks on the banks of the river, namely McKay and Goldie Parks and contain picnic areas, play equipment and barbeques.

19.4 Impact Assessment

The Proposal has the potential to have both positive and negative impacts on people at a number of levels including as landowners and residents and the community. Potential impacts of the construction phase are expected to be temporary, and would generally occur for the duration of the construction phase, while potential benefits and impacts of operation would be more permanent or longer term. However, there are some benefits and impacts that may also begin during the construction phase and continue during the off river storage operation. A qualitative assessment of the range of potential impacts that could arise from the construction and operation of the Proposal is outlined below.

19.4.1 Regional Community Impacts

The Proposal would have the following social and economic impacts at the regional level.

- Employment opportunities;
- Increased water security in the region;
- Increase in the typical residential bill for water;

- Assist with the implementation of *the Mid North Coast Regional Strategy* actions relating to ensure long term regional water efficiencies and improved drought security;
- Much of the agricultural activity in the Nambucca LGA is dependent on irrigation; for example, horticultural crops and dairying all use the Nambucca water supply. Dry land crop production is also carried out in some parts of the LGA. The proposed water storage would protect the performance of existing entitlements and provide additional allocations;
- Increased economic activity and business, especially during the construction phase, may also provide impetus for filling service gaps, as professionals and businesses decide to remain or relocate in the area; and
- There is already significant population growth in coastal parts of the LGA and further growth is predicted associated with additional water supply. The proposed storage is likely to improve the economic outlook for the LGA and contribute to population stability and growth.

19.4.2 Local Community impacts

Construction phase

Impacts during the construction phase have the potential to disrupt local traffic on local roads, particularly if the works cause delays, interruptions or additional travelling time. The duration of any such disruption would depend on specific construction staging plans.

However, any potential adverse impacts on the community during construction would be temporary. In addition, community consultation would be undertaken throughout the project planning and construction phases to ensure that community members have adequate information about the Proposal and the timing and scope of activities in their local area. There are not expected to be any ongoing community cohesion issues arising from the construction phase.

Operation phase

At a local level, both positive and negative impacts could be experienced during the operational phase. Where the construction phase would be associated with a higher potential for negative impacts, particularly as a result of disruption and impacts on local amenity, the proposal has the potential for significant positive impacts during the operational phase. Potential social and economic impacts during the operational phase include the following.

- Community identity and interaction: Infrastructure, such as the Proposal, can promote community identity, as it can be a meeting place and a focal point for activity. However, it can also have negative impacts on identity as the character of the place changes due to differences in community structures and behaviours.
- Social interaction: social interaction refers generally to the extent to which individual or group actions promote a high level of interaction. The presence of a large water body has the potential for passive recreational activities such as bird watching and bush walking which can promote social interaction.
- Amenity impacts: The operation of the proposal has the potential to create amenity impacts such as noise and vibration (refer to chapter 12) and visual impacts (refer to chapter 16). The potential for negative amenity impacts would be significantly reduced by the implementation of appropriate design features (such as noise mitigation) and stringent

environmental management controls guided by the construction and operation environmental management plans.

- Severance: this relates to the extent which the Proposal or related activities (such as construction activities) have the potential to physically divide a community. The Proposal would include severance impacts of Viewmont State Forest. There has been ongoing development of the design for the Proposal to ensure retention of all possible access arrangements and to minimise the separation of areas of the State Forest (refer to Chapter 21 -Land Use for further information).
- Economic Loss: The proposal would have an economic impact on Viewmont State Forest, through loss of productive forest lands.
- Increase in Skilled Workforce: The Proposal has the potential to promote a skilled workforce through the offer of possible cadetships with the construction contractor
- Periods of boom and bust: Some local businesses may experience a boom during the construction period followed by a sudden downturn following completion. This would be most noticeable for food, beverage and hardware shops and accommodation.
- Acquisition and dislocation: The majority of the storage area is currently under Department of Industry and Investment (DI&I) control. Land acquisitions for the storage have progressed to a stage where all private land is in NSC ownership and an agreement has been reached with DI&I for their land and is subject to the finalisation and satisfactory determination of the EIS (refer to Chapter 21- Land Use). The only land needed is for easements for pipelines, borefield collection system and power etc. Details of the specific properties (or parts of the properties), which would need to be acquired, are set out in (refer to Chapter 21- Land Use). Typical social impacts associated with acquisition are outlined in Table 19-9.

Table 19-9 Potential social impacts associated with acquisition

Residential	Rural	Industry
• Anxiety • Amenity • Financial distress • Isolation • Severance from community	• Loss of agricultural land production • Relocation costs • Locating suitable alternative accommodation	• Financial concerns • Relocation costs • Locating suitable alternative accommodation • Staff anxiety • Operational difficulties • Market impacts

Ongoing communication, consultation and liaison with property owners have ensured they are aware of project developments and timeframes. Likely Impacts would be conveyed and discussed with affected landowners during project planning and construction to ensure all affected landowners are cognisant of the process.

19.4.3 Business Activity Impacts

Job Creation Impacts

Development of the Proposal would have significant job creation impacts, particularly if a local construction contractor or subcontractors are engaged. These jobs would be principally during the construction phase of the proposal. Previous projects of similar size to the Proposal have generated in the order of between 20- 30% local jobs.

Construction phase

Whilst it is recognised that Forests NSW would be the most affected (through the acquisition of land) business by the Proposal, acquisition of land via easements would also be required over a number of rural properties which are operated as agricultural businesses.

Potential positive impacts may occur as a result of increased demand for food and services by the construction workforce during the construction period, and as a result of increased visitation to the area. This includes potential increase in business activities and growth in the vicinity of Bowraville and it is considered that the presence of the Proposal would support further growth of Bowraville. Growth in this town especially in terms of tourism growth and the larger role it could play in the region would result in positive economic conditions for local businesses and the community. In addition, the construction phase of the Proposal is expected to provide a range of opportunities for local contractors, subcontractors and suppliers, including plant operators and hire, and transport services.

If not managed effectively, there is the potential for impacts on the operation of businesses in and around Bowraville. Potential impacts could include increased heavy vehicles through and around town, traffic delays during the movement of heaving machinery/ equipment, reduced availability of car parking and a reduction in the general amenity of the area.

During construction, impacts created by traffic/parking and noise/vibration would need to be managed to ensure that potential impacts experienced by businesses in the locality are minimised (refer to chapter 15 – Traffic and 12 – Noise and Vibration).

Operation phase

Property acquisitions for the proposal would result in the reduction in the size of the State Forest. However, it is unlikely to impact on the viability of State Forest as it is only a small proportion of its total productive land.

The provision of a reliable urban water supply would provide the opportunity to support and attract new business activity and expand existing businesses and industries within the LGA. This includes opportunities for development of a wider range of tourism facilities, including eco tourism, resort accommodation and convention centres (NSC, 2008).

The development of new businesses and industry and expansion of existing business and industry would have benefits such as increased employment and income levels.

19.4.4 Impacts on Primary Industry

Construction Phase

The Proposal would involve the transfer of 220 ha of land currently used by Forests NSW for forestry purposes. Upon transfer of this land it would no longer be available for commercial forestry purposes with the majority removed and the area inundated.

The Proposal would also involve the creation of easements over the proposed pipelines, borefield collection system and power lines. The property requirements for these easements would result in a minor reduction in the capacity of some rural properties. However, due to the holding size of the affected properties, would not impact their viability. In addition, access arrangements to these rural properties would not change. Any acquisitions would be undertaken in consultation with landowners, in accordance with the terms of the *Land Acquisition (Just Terms Compensation) Act 1991*.

The construction of the proposed pipelines, borefield and power lines may cause temporary disruption to activities that occur on the affected properties. The location of the proposed pipelines, borefield and power lines have been cost effectively located to ensure the least impact on the landowners and the environment.

Once operational, the Proposal is not expected to result in any adverse impacts on affected rural properties.

Economic Value of Storage Area

As the Proposal involves a change in the land use from State Forest and agricultural land to water supply, consideration has been given to the value of each land use to the local economy.

Value of State Forest

DI&I have advised that the vegetation within the inundation area comprises both plantation and native forest. Of the native forest component, 26 ha is available for harvesting with 16.1 ha unavailable for harvesting under current native forest logging rules primarily due to drainage line buffers.

All but about 1 ha of the plantation timber would be able to be clearfelled under DI&I plantation harvesting rules. There is a 20 metre harvesting exclusion on all third order and above drainage lines within the proposed inundation area.

The harvestable plantation area is estimated to have a total standing volume of approximately 170 tonnes per ha. Of this 120-130 tonnes is estimated to be merchantable, leaving 40 – 50 tonnes per ha of residual waste. The total standing volume of the native forest component of the ultimate inundation area is estimated to have a total standing volume of approximately 200 tonnes per ha, of which approximately 50 tonnes per hectare is merchantable leaving 150 tonnes per hectare as residue. The value of the native forest is valued at $7,500/ ha gross within the inundation area whilst the plantation timber is approximately $2,500/ ha gross.

Assuming 32.65 ha of native vegetation and 25.94 ha of plantation timber is considered millable, the gross economic loss of these resources to the local economy would be in the order of $309,725. Given the timber resources take at least 20 years to mature and the Proposal has an assumed lifespan of 40 years, it is estimated that the annual income from the timber resource would be in the order of $15,500/annum over the 40 year period.

Value of Agricultural Land

Approximately13.55 ha would be removed from production as a result of the Proposal. Current estimates based on the soil type, location, aspect and accessibility to water suggest that the cleared agricultural land could generate between $500 - $1,000/ha per annum depending upon whether the land is used for grazing or cropping, with cropping generally fetching the upper limit. Assuming the best case scenario of $1,000/ha /annum, the agricultural land could generate in the order of $13,550/ annum over the 40 year period.

Value of Proposal

The Proposal would provide a water supply resource of 5,500ML. NSC's current charge for water is $1.37/ kilolitre. Assuming all water can be sold at current usage rates of 8 ML/ day, the water supply resource would have a value of $4,000,400/ annum (2,920,000 KL x $1.37) over the 40 year period. Even accounting for real and apparent losses and government use in the order of 19%, the value of the water supply resource would still be $3,240,324 / annum.

19.4.5 Impacts on Industry

Construction phase

The construction of the Proposal would have potential benefits for manufacturing industries (eg. concrete batching plants and nurseries) in the LGA, which may provide materials for construction. Construction materials would be sourced from local industries and manufacturers, where possible, to maximise the potential economic benefits of the Proposal on the local economy. Potential impacts could occur for existing manufacturing and construction contractor businesses in relation to increased demand for skilled and unskilled labour.

Operation phase

Industry in the LGA would benefit from the Proposal through the provision of a reliable urban water supply. This would provide opportunities to support and attract new businesses activities and industry and expand existing businesses and industries within the LGA. This includes opportunities for development of a wider range of tourism facilities, including eco-tourism.

Relocation Costs

No businesses are required to be relocated as a consequence of the Proposal, however a portion of the Viewmont State Forest would be transferred when the Proposal is eventually constructed.

19.4.6 Impacts on Property Values

Construction phase

Two residences are located close to the proposed construction site and would be potentially affected by the construction works. Potential impacts of construction activities would include noise, dust, and traffic disruptions.

It is expected that any impacts on property values near the Proposal would be site specific and largely dependent on the location of the property relative to the construction works. Potential impacts on property values during construction would also be temporary.

Operation phase

In the longer term, there are not expected to be any tangible detrimental changes in property values from the operation of the Proposal either as a result of noise, dust or visual amenity. Whilst there may be some concerns raised over the visual impacts of the Proposal, particularly the proposed new borefields and storage embankment, these are not expected to have any tangible bearing on property values. The acquisition of the easements required for the Proposal in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* would ensure affected landowners are appropriately compensated.

19.4.7 Future Property Development

The availability of a reliable water supply is a major constraint to the future growth and development in the Nambucca LGA and additional urban water is required to allow any future urban growth in the LGA (NSC, 2008). The existing urban water supplies are limited in capacity and the supply came close to failure during the extended dry period of 2002/03.

The provision of a reliable urban water supply would allow future residential development within the LGA's urban areas. The LGA has experienced growth in residential development and dwelling approvals in recent years and the *Nambucca LGA Structure Plan* (NSC, 2008) predicts further increases in building approvals. The Structure Plan predicts construction of an additional 3,954 new dwellings, to cater for new residents over the next 20 years. It is estimated that the Proposal together with other water management measures would satisfy the urban water demands of the LGA for another 40 years (IWCM Strategy, 2009).

19.4.8 Housing and Accommodation

Construction phase

It is expected that there would be up to approximately 60 workers required during the construction of the Proposal. This includes approximately 10 management and support staff (i.e. project managers, supervisors etc) and approximately 50 labourers, contractors and subcontractors.

It is expected that some of these workers would commute from surrounding urban centres such as Nambucca Heads (approximately 23 minutes drive to Bowraville) and Macksville (approximately 16 minutes drive to Bowraville). However, it is also expected that other workers would relocate to either Bowraville, either full-time for the duration of the construction phase or on a part-time, weekly basis (i.e. Monday to Friday).

Construction of the storage is expected to commence in mid 2011 and take over 18 months to complete. The peak workforce construction period would be during the construction of the storage embankment. This is expected to take up to 12 months.

It is expected that demand for accommodation from the construction workforce would be for temporary accommodation, such as hotel and guest accommodation, and permanent accommodation, such as rental housing. It is unlikely that construction workers would look to buy houses in the local area. It is anticipated that the majority of workers would seek accommodation within or close to Bowraville, Nambucca Heads, or Macksville.

There is likely to be an increased demand for rental accommodation in Bowraville, Nambucca Heads and Macksville during the construction phase. Where sufficient accommodation is not

available, locations such as Bellingen, Urunga and Scotts Head may also experience demand for accommodation. Given the amount of rental accommodation within 30 minutes of the Proposal, the demand for accommodation is unlikely to result in an increase in rents or impact the seasonal availability of accommodation during holiday periods.

The construction phase is also expected to increase demand for temporary accommodation options, such as motels and other 'guest' accommodation, particularly within the Bowraville urban centre and in those localities close to the proposed worksite. The use of some of the available, under-utilised tourist accommodation for temporary workforce accommodation would provide economic benefits for accommodation owners by providing a base load demand.

The use of tourist accommodation such as motels and guesthouses would help to minimise potential impacts on rental accommodation. However, early consultation with local accommodation providers and tourism development associations would be undertaken to ensure that accommodation demands can be managed, particularly during peak tourist times.

Early consultation with community support agencies would also be undertaken to ensure that impacts for low-income earners resulting from potential increased demand for rental accommodation could be appropriately managed.

Maximising the use of local labour would also minimise the influx of workers during construction and minimise subsequent impacts on the local rental housing market. However, the existing availability of appropriately skilled and qualified workers, may impact on the ability for construction workers to be sourced locally.

Operation phase

Following construction, it is expected the NSC's existing workforce would operate the Proposal. As such, there is not expected to be an increased demand for housing and accommodation as a result of operation.

The availability of a reliable urban water supply is identified as a key constraint to the future urban growth and development in the LGA. The provision of a reliable water supply would provide opportunities for the development of additional housing and tourist accommodation in the LGA.

19.4.9 Economic Impacts

The provision of new infrastructure, plus the injection of approximately $45.6M (2009 dollars) for the construction of the Proposal, would create a significant stimulus to the local and regional economies, particularly local construction and accommodation businesses. The injection of capital from up-skilling of labour, and increased capacity and capability of local businesses that provide goods and services for the construction of the Proposal would provide short term benefits to the local community.

Negative impacts are mostly restricted to the construction stage and at the local level. They would result from the displacement of local agriculture in the area of the Proposal and to those subsequent businesses dependant on them.

Urban Water Supply

The Proposal would supply the Nambucca LGA, providing additional water and improving the reliability of water supply for the LGA. This would support planned future development.

If the proposal does not proceed, Nambucca LGA NSC would need to cap its current level of development as the potential demand may exceed the existing water supply. As such, the level of planned development in the LGA would need to be reduced, and growth in population would not be possible.

There is considerable development demand in the LGA and a "no action" outcome would require a complete change in perception and lifestyle for the Nambucca LGA community.

Capital and Operating Costs

Capital Costs

The capital cost estimate of the infrastructure has been shown to be around $45.1M for the Proposal. The estimate of capital cost is shown in Table 19-10.

Table 19-10 Capital Cost Estimate

Storage Infrastructure	$ 24,600,000
Project Infrastructure	$ 20,500,000
Project Total	$ 45,100,000

The above estimate is indicative, order of cost only, and would not be used for budget setting or any other purpose excludes all land acquisition costs and easement compensations, initial and on-going environmental management costs, professional fees, GST, interest and cost of finance.

Initial environmental management costs estimated for the Proposal are identified in Table 19-11.

Table 19-11 Environmental Costs - Capital

Activity	Estimated Cost (2009 dollars)
Weed management	Estimated 200 hours @ $60/hr
Installation of rock fish ladder at existing pipeline crossing and other riverbed and bank stabilisation (as required)	$100,000
Erosion and sediment control works (grass/ pasture seeding over disturbed areas including pipeline routes, dam embankment, underboring establishment locations etc)	$5,500/ha
Plantings around recreation area	50 @ $5.00 each

Operating Costs

Annual environmental management and maintenance costs estimated for the Proposal are identified in Table 19-12.

Table 19-12 Environmental Management Costs - Operation

Activity	Estimated Cost (2009 dollars)
Weed management (NSC owned land only)	Estimated 30 hours per month @ $60/hr
Watering of erosion and sediment control works and new plantings	2 days/ month @ $600/ day (for 2 months)
On-going monitoring	Subject to finalisation of adaptive management framework

Water Rates

The *Nambucca Shire Council – Integrated Water Cycle Management Strategy* (NSW Department of Commerce, 2009) presents a proposed approach to managing Council's future water, wastewater and stormwater resources in an integrated and holistic manner. The works assessed in this EIS are consistent with and a component of that strategy.

The IWCM quantifies the impact on the typical residential bill of implementing the Proposal, considered as Scenario 3 in the IWCM. The report develops a financial model utilising the NSW Financial Planning Model (FINMOD) developed by the former Department of Energy, Utilities and Sustainability (DEUS).

Based on a 40-year capital and renewal works cost of $122.1 M dollars, the report estimates the typical annual residential bill to increase from $335 to $542, which is an increase of 61 percent ($205 increase). The developer charges are likely to increase from $4,000 to $9,120 per residential lot, which is an increase of 128 percent. The report estimates the borrowings are expected to be paid by the year 2029/2030 (NSW Department of Commerce, 2009).

The increase in the typical residential bill and developer charges may have impacts on the social environment particularly for low-income earners in the LGA. However, the provision of a reliable water supply is necessary for the future growth and sustainability of the LGA (NSC, 2005). The development of a reliable supply is also seen as important for the future development of the LGA's industries.

19.4.10 Potential Recreational Benefits and Impacts

The Project is not expected to have an adverse impact on existing recreation facilities and activities during either the construction or operation phase.

An increase in the LGA's population during the construction phase from staff involved in the Project could have benefits for local sporting clubs and sport and recreation facilities through increased membership and participation in sporting activities.

As the main objective of the Proposal is to provide a secure water supply for the Nambucca LGA, the proposed storage area would not be available for active recreational uses such as motorised boats, water skiing and jet skiing, canoeing, and fishing. Recreational benefits offered by the Proposal would be limited to passive recreational activities such as bird watching and bushwalking. There is potential however to develop an integrated network of passive tourism and outdoor recreation opportunities (including facilities) in Bowraville, of which the Proposal could be a part, in order to maximise the attraction of the area for residents and visitors of the Nambucca LGA. The Proposal offers an opportunity for building on existing passive tourism and

recreation-based activities such as bird-watching and bush walking in the area. Whilst not a venue on its own, the Proposal could form part of a co-ordinated approach to optimise the strategic advantages of Bowraville in terms of its physical setting and natural values, and its location relative to a range of tourism markets such as the Coffs Coast.

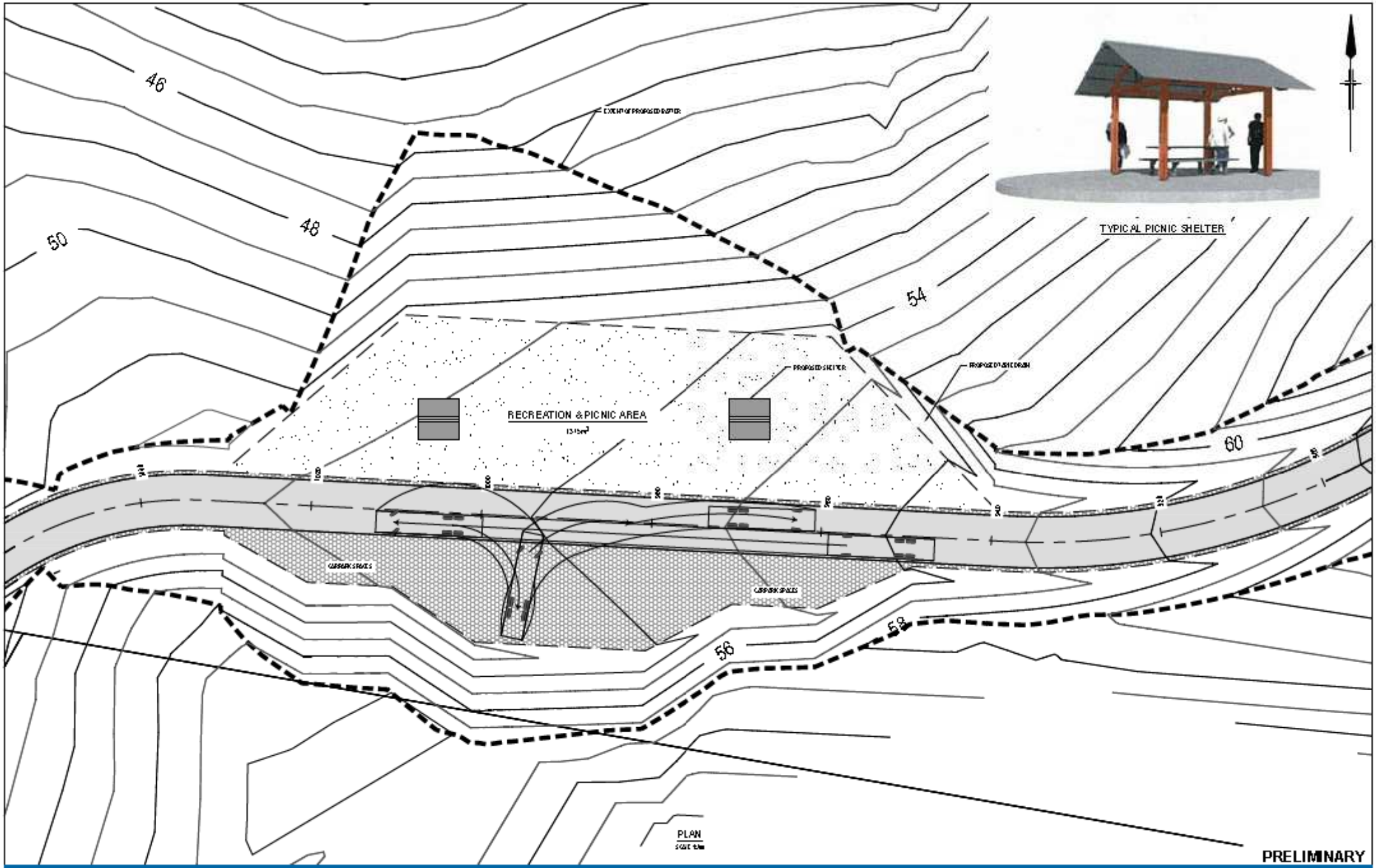
Proposed Recreational Facilities and Activities

Following construction of the Proposal, there is opportunity for a range of informal recreation facilities to be provided adjacent to the inundation area. These are listed below in order of priority of provision in accordance with a community needs assessment and water quality and ecological objectives.

1. Viewing platform.
2. Picnic area.
3. Shelters.
4. Toilet facilities.

Facilities, such as picnic tables and toilet facilities, would be located adjacent to the inundation area in an area of approximately 3000 m^2. This area would also include car parking spaces (approximately 14 spaces). Figure 19-1 demonstrates the concept plan for this recreational area.

It is likely that exclusion of water activities such as motorised boats, water skiing and jet skiing, canoeing, and fishing would be imposed so that water quality and ecological objectives are achieved. It is anticipated that the area would be used only for passive water based recreational activities, such as picnics or bushwalking.



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Approved			
Date			
Scale AS SHOWN			

Client: NAMBUCCA SHIRE COUNCIL
Project: BOWRAVILLE OFF RIVER STORAGE
Title: ACCESS ROADS CONCEPT DESIGN
RECREATION & PICNIC AREA PLAN

Size: A1 Drawing No: 22-14133-16-C105 Rev: A

19.5 Mitigation Measures

The identification of potential mitigation strategies to maximise the community benefits and minimise any adverse socio-economic impacts are outlined below.

These would be read in conjunction with mitigation measures identified for other aspects of the Proposal including; air quality (Chapter 7), noise (Chapter 12) and traffic (Chapter 15) and visual assessment (Chapter 16).

19.5.1 Construction Phase Management Measures

The successful management of the potential social and economic impacts requires continued involvement by community stakeholders during the environmental assessment and construction phases of the proposal.

Key management measures for the construction phase are identified in Table 19-13 and would be read in conjunction with measures identified in other chapters including traffic, noise/air quality and visual/landscape.

Table 19-13 Construction phase management measures

Potential benefit or Issue	Management Measures
Property access	• Provision of traffic management procedures to manage access issues during construction.
Increased demand for rental accommodation - this may temporarily increase rental costs, particularly impacting on households with low and very low incomes.	• Where possible, construction workers would be sourced locally to minimise the number of workers needing to relocate to the LGA.
Increased demand for short-term tourist accommodation during construction.	• Ensure ongoing consultation and notification with local tourist accommodation providers and tourism development associations regarding accommodation needs, and peak periods of tourist accommodation demand (i.e. peak tourist season, festivals, etc)
Safety for road users during construction due to an increase in construction traffic, including heavy vehicles.	• Implement a construction traffic management plan (CTMP) to ensure safety for motorists and other road users is maintained. • Communicate changes to local access and traffic impacts to local residents and tourists, including potential for delays and disruptions. • Regularly monitor haulage routes during the construction period and repair damage caused by construction traffic.
Reduced amenity in Bowraville as a result of increase in heavy vehicles through town, reduced availability of car parking spaces and increased noise and exhaust fumes	• Minimise movement of heavy vehicles through town during business hours or identify alternate route as part of CRTMP. • Contractor to minimise the parking of heavy vehicles in town during construction phase.
Access and movement patterns impacts on Forests NSW	• DI&I would have access to areas of State Forest land identified for acquisition to remove any harvestable timber within the footprint of the Proposal prior to commencement of

	construction.
Potential benefits for manufacturing industries in the LGA, which may provide materials for construction.	◗ Where possible, construction materials would be sourced from local industries and manufacturers.
Impact on residential amenity, including increased noise and dust.	◗ Ongoing consultation with local residents in the vicinity of construction works would be undertaken to ensure potential impacts are identified and appropriately managed. ◗ Provision of appropriate noise management measures during the construction and operational phases. ◗ Appropriate environmental controls during construction in order to maintain the environmental amenity of the surrounding environment: • Water quality / detention basins. • Dust management measures. • Blasting and noise control measures

19.5.2 Operation Phase Management Measures

Key management measures for the operational phase are identified in Table 19-14 and would be read in conjunction with measures identified in other chapters including traffic, noise/air quality, and visual assessment.

Table 19-14 Operation Phase Management Measures

Potential benefit or Issue	Management Measures
Restriction on use of land surrounding the inundation area.	◗ Communicate potential restrictions on land use and farming and land management practices for properties surrounding the inundation area.
Change to property access	◗ Access to individual properties would be maintained. ◗ Early consultation would be undertaken with property owners whose access may be altered to ensure potential issues are appropriately managed.
Increase in water rates on residential user bills	◗ Communicate potential increase in rates to all users and the benefits of a secure water supply.

19.5.3 Recreational Management Measures

Given the potential for decreased water quality and contamination of the water supply, motorised boats, water skiing and jet skiing, canoeing, and fishing would not be permitted within the storage.

20 Utilities and Infrastructure

20.1 Introduction

The aim of this Chapter is to determine the level of impact from the construction and operation of the Proposal on surrounding utilities and infrastructure.

20.2 Existing Conditions

20.2.1 Electricity

Country Energy (CE) is the supply authority for the locality being investigated. CE is not a party to the Dial Before You Dig (DBYD) scheme which provides location information for utilities. Information has been obtained directly from the GIS system operated by CE.

The GIS information generally identifies the location and alignment of reticulated electricity supplies together with the location and identification of transformers and circuit breakers. The facilities have been located in the field with global positioning system (GPS) equipment.

There are two existing Country Energy 11kV feeders supplying the Bowraville area, including the borefield and headworks:

- 'Bowraville Town' - supplied from Newee Ck Substation; and
- 'Bowraville Rural' - supplied from Newee Ck Substation.

Both of the feeders come from the Newee Ck Substation at present, approximately 10km away. They are due to be diverted to a new South Macksville substation in 2009, owing to a planned upgrade of the existing Transgrid 66kV transmission line supplying Newee Creek. This transmission line, running from Kempsey to Nambucca then onto Coffs Harbour, would be upgraded to 132kV. Following this upgrade, the Newee Creek Substation would be decommissioned.

Country Energy has provided preliminary information about these two 11kV feeders supplying Bowraville, outlined in the following table.

Table 20-1 Country Energy feeders to Bowraville

'Bowraville Town' Feeder
Route length = 19km from South Macksville Substation (approaches Bowraville from NE);
Capacity = 2.5-3.0MVA (900kVA spare capacity available);
Last upgraded in 2006.
'Bowraville Rural' Feeder
Route length = 17km from South Macksville Substation (approaches Bowraville from SE);
Capacity = 2.5-3.0MVA (very little spare capacity available);
Last upgraded in 2006.

Power Supply to Existing Infrastructure

A single 11kV overhead distributor supplies the existing pole mounted 500kVA substation (CE No.31983), beside the existing Bowraville Water Headworks. This supplies 3 borefield pumps (Bores 2, 7 and 8) on the north side of the Nambucca River.

The same 11kV distributor also supplies the three borefield pumps (Bores 3, 4 and 6) on the south side of the river via a separate 300kVA pole-mounted substation (CE Number 32112).

A third pole-mounted substation (50kVA) supplies 2 additional borefield pumps (Bores 9 and 10) added to the original borefield on the opposite side of the river around 1983.

20.2.2 Water

NSC is the water supply authority for the area investigated. GHD has received GIS information directly from NSC and that information has been added to the GIS model being used for the Proposal. Details of the existing water reticulation layout through the borefield, as well as the existing rising main to the balance tank and supply reticulation along Bellingen Road as far as Paulownia Place have been reviewed.

The existing borefield is connected to the headworks with a network of rising mains ranging in diameter from 200mm PVC to 375mm AC pipe.

The rising main from the headworks to the balance tank is a 450mm MSCL pipe. From the headworks the pipe generally runs in a south-easterly direction through Lot 326 DP 777074 to Bellingen Road near the corner of Lot 14 DP 253386. The pipe is laid on the eastern side of Bellingen Road and continues past High Street along Rodeo Drive, then cuts directly through private property to Valla Road and then along Balance Tank Road.

At various points along the pipe there are local supply off takes. A 150mm main off take is located at High Street and supplies the Bowraville urban area. A 40mm local supply main is located on the western side of Bellingen Road from High St to Paulownia Place and supplies dwellings in that area. There is no supply to any properties further north along Bellingen Road north of Paulownia Place.

20.2.3 Sewerage

NSC is the sewerage authority for the area investigated. GHD has been advised by NSC that there are no sewerage services in the areas likely to be affected by the works.

Sewerage services in the shire are generally restricted to the urban areas of Nambucca Heads, Macksville, Bowraville and Scotts Head.

20.2.4 Gas

The DBYD inquiry indicated that there is no reticulated gas supply located in the study area.

20.2.5 Telecommunications

The DBYD inquiry indicated that Telstra is the sole network provider in the study area. In certain locations AAPT and Optus may also provide infrastructure, but this is unlikely.

Details of the telecommunications infrastructure located in the area as received from Telstra, indicates that throughout the study area only telephone cable exists. Generally, most houses

located in the area have a telephone line connection. Multiple lines on some properties indicate that line services may be connected to work sheds as well as the dwelling. Line services may be either in-ground or aerial within properties and along road reserves. No optic fibre was identified on the supplied plans.

Investigations into mobile phone coverage in the area reveals that the Telstra Next G network, Which is now used by most network providers, provides coverage for voice, picture, TV, video, and broadband within the vicinity of the Proposal. Although there may be poorer coverage requiring an external antenna within the storage area.

Landline mapping details received from Telstra indicate a 20 pair cable laid into the headworks. Some of the lines may be dead.

The closest landline laid toward the Proposal runs to the dwelling on the property owned by T Lewis Lot 2 DP 1076377 from Bellingen Road. The end of the line is approximately 200m from the eastern end of the storage embankment. The shortest alternative route from Valla Road would be approximately 800m long through a mixture of grazing land and forest.

When the transfer pipeline is laid from the headworks up to Bellingen Road and then through the property owned by Smith, Lot 3 DP 253386, the pipeline would intersect Telstra infrastructure at 3 separate locations.

20.3 Impact Assessment

20.3.1 Construction Phase Demands

Electricity

The construction activities generally are not expected to result in a high demand for electricity consumption, but still may be expected to exceed the existing supply.

It is expected that most construction activities in the area of the headworks would be powered from the existing supply. Activities would include powering the site office and office equipment and generally small power tools, saws, winches etc.

In situations where supply is not readily available, such as when constructing the main pipeline to the storage, the construction contractors would use portable generators for electrical equipment. There would also be a high proportion of self powered tools and equipment used.

A permanent power supply would be required at the storage to power pumps, valves, communications and for general use. It would be cost effective to provide a temporary power supply to the site with the ability to be used for the permanent supply at the time of commissioning. The CE maps indicate an 11kV supply running to private properties below the storage site.

Extension of the supply to the valve house would be approximately 600m from the Ussher property or 500m from the Lewis property.

A temporary supply from the valve house to the proposed recreation/viewing area, likely to be used for housing the works offices, would be approximately 2,000m in length. All temporary supply works would be expected to be via aerial cabling.

Water

Water supply for construction activities would be required for personal use and also construction works.

Potable water would be required at the main worksite offices and amenities located at the headworks and at the storage. Potable water would be required for drinking, washing and ablutions. During the main pipeline construction and extension of the borefield small supplies of drinking water would be carried in vehicles and portable WC's would be provided in locations not convenient to the main ablutions.

NSC has advised that arrangements could be made for potable water to be made available from a dedicated standpipe located in the vicinity of the intersection of Rodeo Drive and Valla Road. No licensing would be required however, the standpipe would be metered and the contractor would be charged at the usage rate applicable at the time.

Water used for construction purposes, whilst not required to be fully potable, is normally of similar quality to reduce the risk of contamination of the works. However, water from sedimentation basins and dewatering activities would also be collected and reused where possible. Where dewatering is undertaken in an area with the potential of being contaminated, collected water would be disposed of at the Bowraville Sewage Treatment Plant. The main uses for this water would include dust suppression of Bobo and Valla Roads, other access and haul roads, and water required to condition earth and clay fill for the embankment earthworks.

Sewerage

There are not expected to be any demands on sewerage as part of the Proposal. A single WC is available at the existing headworks and would be available for construction staff during the construction phase. However, it is expected that a single WC would be inadequate and the capacity of the absorption trench may be exceeded. It would be expected that all construction activities would be serviced by "portaloos" with the effluent being conveyed to NSC's nearest treatment works for treatment. NSC has advised that the closest wastewater plant with facilities to receive sewage from tankers is located at Macksville. The contractor would be charged the usage rate applicable at the time for the disposal of sewage.

Telecommunications

It is anticipated that line telephone services would be utilised for voice and data communications at both the off-river storage and headworks construction sites provided suitable extensions and capacity exists.

Coverage is expected across most of the study area. Most communications would be via mobile phones or CB radio.

The capacity of existing line services to provide business grade ADSL or BDSL data services would need to be confirmed with Telstra. The availability of a suitable service on an existing line to the headworks for example does not guarantee that additional lines of similar capacity would be available.

20.3.2 Operational Demands

Electricity

An assessment of power supply options for the proposed upgrade to the NSCs water supply system at Bowraville (including a new storage) indicates that there is limited spare capacity available in the existing Country Energy 11kV network, without some form of upgrade or possibly the addition of new feeders.

The existing borefields and headworks already make up a significant part of the demand on the two Country Energy 11kV feeders supplying Bowraville from the Newee Creek substation. This substation is due to be closed next year and the feeders would be supplied from a new substation being planned in South Macksville.

Country Energy has now been involved in discussions with NSC, the Department of Commerce and GHD about the Proposal and has been fully informed of the scope and timing of the project, which is in the concept design phase at the moment. In parallel with this report, Country Energy is undertaking preliminary modelling to clarify the impact the upgrade would have on their network and would advise NSC of options for augmenting their network to satisfy the requirements of the future system.

It is estimated that the proposed upgrade to pump water from an additional 24 bores over an expanded borefield to the headworks and the new raw water pumping station pumps to pump water to the storage would require an estimated annual electrical energy usage of 28,536kWh.

Headworks and Borefield

The bulk of power consumption at the headworks would be required by pumps pumping up to the storage and pumping to the balance tank.

With the starting of motors, Country Energy considers the impact of the running load, motor starting current draw and the frequency of starts on the power distribution system. In the case of the Bowraville water treatment facility, the system is to be upgraded to cater for the proposed loads of up to 24 new bore pumps, the raw water pumping station and possible aeration at the storage site. Where there are large motors to be started such as at the existing high lift pumping station and at the proposed raw water pumping station, Country Energy carries out an assessment on the extent and frequency of voltage dip on the system and likely annoyance to customers such as causing house lighting to dim or televisions to flicker etc.

With the two existing feeders from South Macksville to Bowraville, one is almost fully loaded and the other has some spare capacity. However, voltage regulation is a problem, and it has been determined that Country Energy requires assisted starting for high load devices to reduce voltage dip. Starting for the existing high lift pumps and proposed raw water pumps would be by variable speed drives. Variable speed drives are more able to start the motor in a slow ramp up manner and minimise power demand and voltage dip.

The range of plant and electrical facilities, which may be used in the operation of the headworks and borefield, may include the following:

- Incoming HV Power Supply
- Transformer Substation
- Low Voltage Switchroom
- Main Switchboards

- Metering
- Power Factor Correction
- Emergency Power
- Motor Control
- Motorised Valve Actuators
- Control System
- Instrumentation
- Telemetry
- Distribution Boards and Sub Boards
- Fire Indication Panel
- Pump Station Building Crane

20.3.3 Storage

Facilities to be provided would include a small maintenance shed with power supply for maintenance works as well as power for the compressor associated with the de-stratification system.

Power would also be required for the SCADA system and control actuators etc.

The detailed design would clarify further power system load requirements and explore options for optimising the system efficiency, as well as minimising capital and future operating costs.

Issues associated with the effect that pump starting has on power quality and minimisation of the risk of loss of supply would also be covered in the development of the detailed design following further clarification of details from Country Energy's modelling.

Water

Provision would be made in the headworks to make sufficient potable water available for maintenance, washdown and for ongoing "domestic" purposes by the small number of staff expected to be on the site at any one time. The on site usage is expected to be very minor in relation to the transfer of water through the plant.

Similarly, a water supply and pressure system is required at the off-river storage site for the use of workers engaged in cleaning and maintenance works. It is not proposed to extend a reticulated water supply system to the public viewing area some distance from the storage embankment.

Water would be provided at the viewing area within the proposed amenities, via water tanks, and at the headworks, via the existing reticulation, as part of the Proposal.

Sewerage

The existing WC at the headworks would be demolished to make way for the new headworks building. Alternate amenities would be provided in the ultimate design. Permanent amenities would also be provided at the viewing area. This system would incorporate either a septic system or be a compost facility, designed in accordance with current best practice to meet NSC

requirements. The ultimate system would be dependant upon the availability of water to the area.

Gas

At this time it is not expected that there would any demand for use of LP or natural gas at any of the facilities. If in the future any demand for gas could be supplied by an independent storage tank at the site with refilling from road tankers.

Telecommunications

The existing telephone landline to the headworks is expected to be adequate for future usage. No provision is being made for a new permanent landline to the off-river storage site.

The existing SCADA telemetry system which is used to monitor and control operations at the borefield and at the headworks is an independent system that communicates directly by radio link to NSC's base station. It would be extended and upgraded to cater for the requirements of the expanded operations of the system. The SCADA system is dependent upon the local electricity supply. During times of blackouts the SCADA system would be powered by an UPS until critical functions can be satisfactorily managed.

20.4 Mitigation Measures

Mitigation measures to be adopted as part of the Proposal include:

20.4.1 Electricity

Liaise with Country Energy through the detailed design phase to clarify the impact the Proposal would have on their network and identify options for augmenting the network to satisfy the requirements of the future system.

20.4.2 Water

Any future connections to NSC's water supply network required as part of the Proposal would need to be designed in accordance with current best practice to meet NSC requirements.

20.4.3 Sewerage

The proposed on-site amenities at the headworks and viewing area are to be designed in accordance with current best practice to meet NSC requirements.

20.4.4 Gas

There are no mitigation measures necessary in relation to gas supply for the Proposal.

20.4.5 Telecommunications

There are no mitigation measures necessary in relation to telecommunications for the Proposal.

21 Land Use

21.1 Introduction

This Chapter describes the current patterns of land use and tenure within the study area and investigates whether the Proposal would result in changes to the use of land and/or tenure and the likely impacts associated with these changes.

Table 21-1 outlines the Director-General's and other statutory authority requirements and where they have been addressed.

Table 21-1 Statutory Requirements

Statutory Authority	EIS Requirements	Where Addressed
Director-General's requirements (DoP)	◗ Detail the implications resulting from the loss of forestry land.	Sections 21.2 to 21.4
Department of Industry and Investment (DI&I) (formerly DPI)	◗ In 2004, NSC was advised that the Minister for Primary Industries approved in principle the acquisition of 220ha of Viewmont State Forest at an agreed compensation value, with NSC meeting all costs associated with acquisition. The in-principle agreement was also subject to the areas of native forest being harvested prior to acquisition, and NSC entering into an agreement that provided for Forests NSW harvesting and marketing the timber on the dam site after acquisition. ◗ Specify zoning, present land use and whether special conditions (eg. SEPP 14 wetlands) apply to the land proposed for development or adjacent land.	Sections 21.2 and 21.3
Department of Environment, Climate Change and Water (DECCW) (formerly DECC)	◗ Project is to identify how riparian land is to be managed within the study area as well as the water supply catchment. ◗ Where the proposal may result in impacts on DECC estate or is on land adjacent to DECC estate, an assessment of impact of the development on DECC estate. ◗ Assessment of the measures proposed to mitigate and/ or ameliorate the impact of the development of DECC estate.	Section 21.2

The purpose of this section is to:

- Describe the existing and potential future land uses in the study area.
- Identify the potential property and land use impacts of the Proposal.
- Propose management and mitigation measures for identified impacts.

Amenity-related land use impacts, including noise (Chapter 12), visual amenity (Chapter 16) and traffic (Chapter 14) are not discussed in detail in this Chapter. Social and economic impacts of the Proposal are discussed in detail in Chapter 19. Changes to local and private property access are outlined in Chapter 15.

21.2 Existing Conditions

21.2.1 Land Use and Zoning

The general pattern of land use in the study area is controlled mainly through zoning provisions in the Nambucca LEP as well as the Forest Management Zoning (FMZ) in Viewmont State Forest.

The proposed off-river storage would be partly located within the 1(f) Rural (Forestry), 1(a2) Rural (Prime/Flooding) and 1(a4) Rural (Lower Water Catchment) zones, whilst the transfer and borefield pipelines, headworks and access roads are located within the 1(a1) Rural, 1(a2) Rural (Prime/Flooding) and 1(a4) Rural (Lower Water Catchment) zones under Nambucca LEP.

General land use characteristics of each of the three precincts are described below:

State Forest

The storage area is contained within the Viewmont State Forest. Viewmont State Forest covers a total area of approximately 1,000 ha and is zoned 1(f) under Nambucca Local Environmental Plan 1995. The state forest is located approximately 4 km north-east of the township of Bowraville. The forest is commercially logged for timber (native species), but also provides for the conservation of old growth and significant forest.

Table 21-2 identifies the FMZs within the Viewmont State Forest and the management objective(s) for each zone.

Table 21-2 Forestry Management Zones

Management Zones	Objective
FMZ 2 Special Management	Specific management and protection of natural and cultural conservation values where it is not possible or practical to include them in zone 1. Not available for timber harvesting.
FMZ 3 Special Prescriptions	Management for conservation of identified values and / or ecosystems and their natural processes. The zone is available for timber harvesting but minimised in design and implementation to maintain or enhance the values that the area is zoned to protect.
FMZ 4 General Management	Management of native forests for timber production utilising the full range of silvicultural options as appropriate; and conservation of broad area habitat and environmental values which are not dependent on the structure of the forest. Available for timber harvesting.
FMZ 5 Hardwood Plantations	Management of hardwood plantations to maximise sustainable timber production on a continuing cyclical basis.
FMZ 8 Areas for further assessment	An interim zoning of areas where field investigation is required to determine final Forest Management Zone classification.

Bowraville Rural

South of the inundation area is characterised by agricultural activity comprising predominantly of grazing (beef and dairy cattle), limited crops, heavily forested areas, rural residential properties, sheds, property access, as well as other associated rural uses. The majority of this land is

zoned 1(a2) Rural/ Flooding under Nambucca LEP. The existing borefields and associated Nambucca River water catchment is zoned 1(a4) to protect the quality of the water supply. The proposed pipelines and borefields would affect some of this area.

Native vegetation occurs in a number of areas including along the ridgelines and along creek lines.

In order to protect regionally significant farmland in the Shire, the DoP in partnership with the DI&I has developed the *Draft Mid North Coast Farmland Mapping Project* (2009). This project recognises and conserves the best farmland or regionally significant farmland for current and future agricultural purposes. Planning recommendations for regionally significant farmland focus on protecting the land from development including infrastructure and facilities unless there is an overriding public benefit.

The mapping of the regionally significant farmland reveals that productive farmland coincides with the rich alluvial floodplain of the Nambucca River and South Creek. However, regionally significant farmland does not occur within the storage area.

Bowraville Town

The township of Bowraville is characterised by residential land uses and commercial and is zoned 2(a) Residential under Nambucca LEP. It is located to the south of the Proposal, and would not be directly affected by the Proposal.

21.2.2 Tenure

Land tenure includes private land and public owned land. In general terms, private land affords the titleholder the highest level of independence in terms of land use and possession. Non-private land is largely owned or held by the State of NSW and may be subject to a lease, licence or reserved for a particular purpose such as a community use or road. The tenure for the study area can be divided into the separate uses for the Proposal.

- Storage Area: the inundation area and surrounds are owned by DI&I and would be acquired by NSC following approval of the EIS;
- Pipelines and Borefields: almost entirely private use and currently used for rural purposes.

Mining Leases

There are no current Mining Leases over any part of the lands affected.

Native Title Claims

There are no Native Title Claims over any part of the lands affected.

21.3 Impact Assessment

21.3.1 Construction

The potential for land use impacts associated with the construction of the Proposal would focus on and around the construction sites and structures. All construction activities associated with the storage, including the sourcing of material for the proposed storage embankment, would be conducted within property acquired for the Proposal. However the construction of the transfer pipeline, borefields and power augmentation would be carried out on privately owned land.

A 10 metre wide construction area would be required along the full extent of the proposed borefield collection system, transfer pipeline route, power augmentation and access. Designated locations, yet to be determined, would be required for construction compounds/ temporary holding yards for construction equipment and material. It is anticipated that at least 5 compounds with areas of approximately 600m^2 would be required throughout the construction phase. These compounds would be located on cleared and relatively flat land adjacent to the northern and southern banks of the Nambucca River, eastern and western banks of Bowra Creek and western bank of South Creek in the vicinity of the proposed borefield and transfer pipeline.

Access to the proposed northern borefield during construction would be via an access track across Lot 326 DP 777074 to Bellingen Road. The access track would be constructed with an at grade gravel pavement (approximately 1.0 km) along an existing farm road and fenced cattle run.

Access to the proposed southern borefield during construction would be via an existing access track (approximately 430 m) on Lot 436 DP 710439 and about 540m on an existing Right Carriageway (ROC) on Lot 461 DP 710439 to Borefield Road off North Arm Road.

Access to the bores on South Creek would be along the proposed pipeline routes off North Arm Road.

Access to the transfer pipeline route would be from either end of the easement (i.e. headworks or storage) with other access from Bellingen Road to Lot 102 DP 809380. Potential land use impacts would result from:

- Land use changes around construction sites during the construction period, including establishment of construction compounds/ temporary holding yards for construction equipment and material;
- Traffic movements to and from the construction area;
- Stockpiling of pipelines, bores, spoil and mulch during construction; and
- Construction of the storage embankment and associated buildings e.g. headworks.

21.3.2 Operation

Potential impacts on adjacent land uses owing to the Proposal include:

- loss of productive land (required for access to borefields and transfer pipeline) which could have otherwise been available for rural/ agricultural purposes; and
- altered access arrangements (transformer poles and power, valves etc) including easements may impact upon the current operation of the existing farms impacted by the Proposal.

Inundation Area and Surrounds

The Proposal would require the acquisition of approximately 220 ha hectares of Viewmont State Forest No 1035. The process for approvals and acquisition of state forestland is legislated under the *Forestry Act 1916*.

Amendments would occur to the boundaries of the Viewmont State Forest No 1035 once acquisition of the State Forest is approved. The land would be transferred to the NSC under an

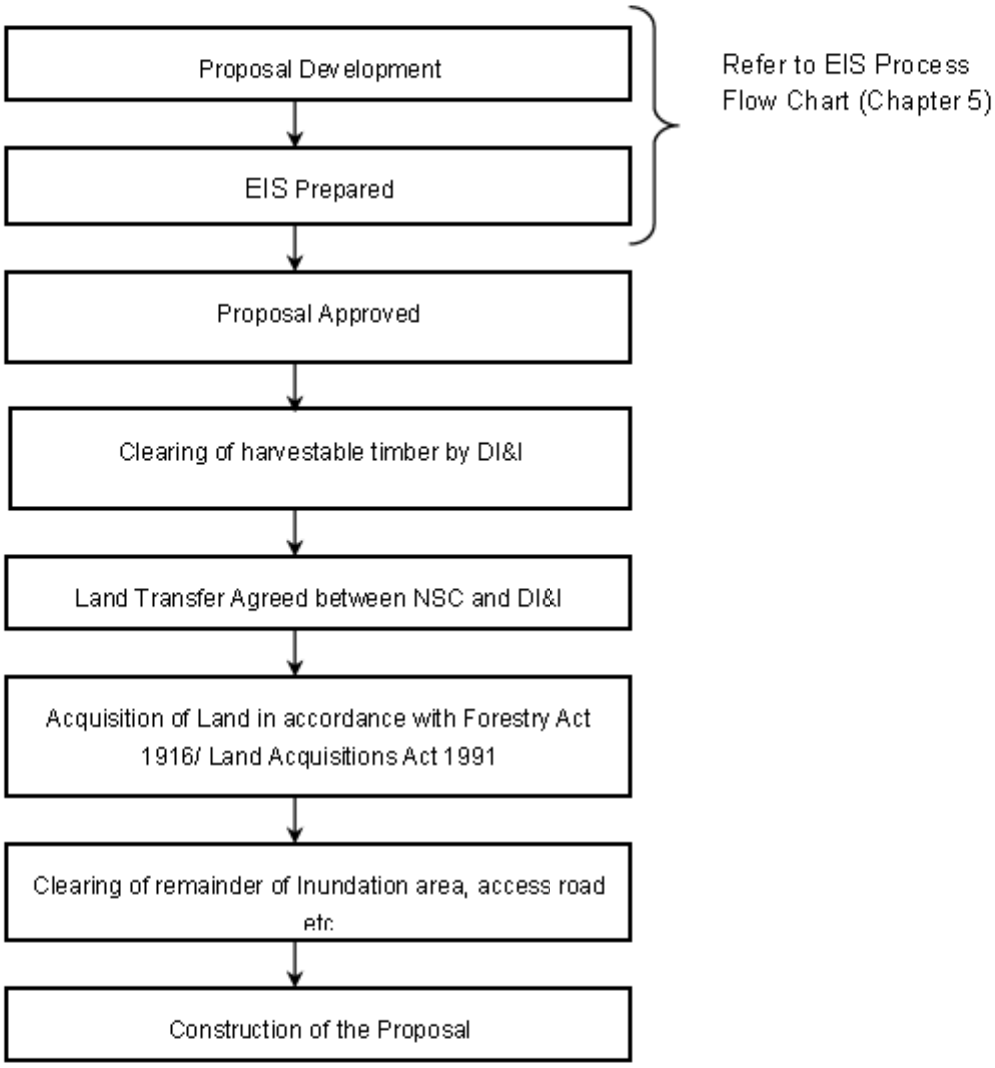
acquisition agreement. The agreement would also include areas of hardwood plantation and native forest being harvested prior to acquisition.

However, action under this Act is not required prior to or during the environmental assessment period. The acquisition approval process under the *Forestry Act* would not take place until it is known whether the Proposal has been approved and the NSC begins land acquisition prior to commencement of construction.

The acquisition area comprises 40% hardwood plantation, 50% general management area, 5% harvesting exclusion whilst the remainder comprises further assessment and special prescription areas. It is not anticipated that there would be any substantial impact on timber production activities or the viability of forestry businesses given the age and low quality of the timber resource (refer to Chapter 19).

NSC would, in consultation with the DI&I, ensure that access to State Forest land is available to the DI&I to remove any harvestable timber within the footprint of the Proposal prior to commencement of construction. A flow chart illustrating the land acquisition process is shown in Figure 21-1.

Figure 21-1 Acquisition and Clearing Process



Land surrounding the storage is undeveloped and utilised for State Forest and limited agricultural purposes.

As a key water storage for the Shire, the maintenance of high quality water is paramount. The catchment would need to be protected from continued forestry operations which would have the potential to impact water quality within the storage. The use of the land around the inundation area but within the acquisition area would be restricted so that water quality, access and ecological objectives are achieved.

Construction of permanent structures, other than fencing, would also be restricted. Quarrying, mining or excavating, and industrial activities would be restricted surrounding the inundation area when the Proposal commences operation.

Pipeline between headworks and storage

Land (via easements) is needed for the transfer pipeline between the headworks and the storage. The properties directly affected by the transfer pipeline are privately owned rural lots as set out in Table 21-3 and Figure 21-2.

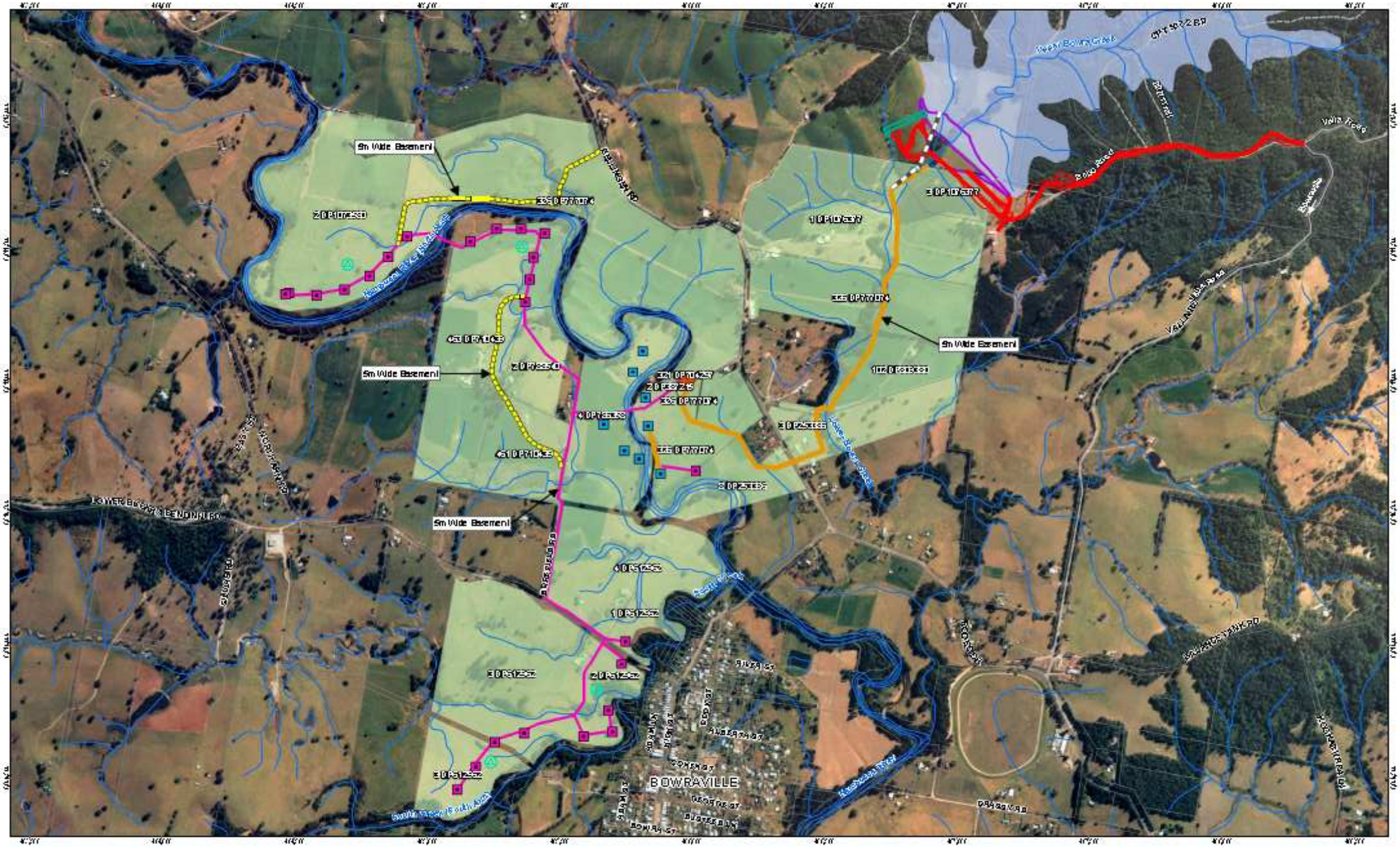
The easements would be 5 metres wide for the full length of the pipeline in order to accommodate the 600mm main with surface fittings to be clear of a 3 m access track and to allow for future operation, repair and maintenance. Access to the easement would be from either end of the easement (i.e. headworks or storage) with other access from public roads or existing easements. A 150m long right of carriageway over the existing access from Bellingen Road to Lot 102 DP 809380 would be determined during the detailed design phase to allow more convenient access to the transfer pipeline.

Table 21-3 Properties directly affected by the pipeline between headworks and storage

Property	Lot Description	Current land use	Total property area (hectares)	Length of Easement (m)	Area of Easement (square metres)
1	Lot 1 DP 1076377	Rural / Private	30.7	385	1,925
2	Lot 326 DP 777074	Rural / Private	19.0	440	2,200
3	Lot 102 DP 809380	Rural / Private	10.8	360	1,800
4	Lot 3 DP 253386	Rural / Private	9.5	270	1,350
5	Lot 8 DP 253386	Rural / Private	1.9	275	1,375
6	Lot 3 DP 1076377	NSC owned	5.4	-	-

It is considered that the location of the transfer pipeline in relation to the existing land uses on these properties would have minimal impact on land use and tenure apart from temporary impacts during construction. The location of the transfer pipeline generally is adjacent to Bowra Creek travelling in a north-south alignment between the headworks and the storage.

The easement is not expected to result in the severance of any affected properties and would result in a negligible loss of productive agricultural land and therefore there is not expected to be any detrimental effect on the ongoing viability of existing farms.


5m Wide Easement
5m Wide Easement
5m Wide Easement
5m Wide Easement
BOWRAVILLE
LOWER BOWRAVILLE
Nambucca River
Bowra Road
Valla Road
Upper Bowra Creek
Bowra Creek
Valla Road
Bowraville Creek
Nambucca River
South Arm
South Arm Nambucca River
Nambucca River
Nambucca River

Borefield Collection System

Land (via easements) would also be required for the proposed borefields, associated pipelines and access. A 5 metre wide easement along the full length of the pipeline would provide satisfactory width for the 150-500mm main with surface fittings to be clear of a 3m-access area and to allow for future operation, repair and maintenance. Power to each of the bores would be taken from a central hub and be laid underground in the easement adjacent to the pipelines.

Where located in private properties, NSC prefers to acquire easement rights over major water mains. Where the pipeline is to be installed in existing easements or where existing access easements are to be used, NSC would need to ensure that it has the right to use these easements, or would need to negotiate with the respective property owners and easement holders for the Proposal. The sections of the proposed pipeline route located in private properties are shown in the following table.

The properties directly affected by the borefields and associated pipelines are privately owned rural lots as shown in Table 21-4 and Figure 21-2.

Table 21-4 Private Properties with Proposed Easement

Property	Lot Description	Current Land Use	L (m)	Area (m^2)*	# Bores
1	Lot 2 DP 1073580	Rural / Private	550	2750	6
2	Lot 326 DP777074	Rural / Private	380 1010	1900 5050	1 Access easement only
3	Lot 463 DP710439	Rural / Private	935 416	4675 2080	7 Access easement only
4	Lot 8 DP253386	Rural / Private	30	150	1
5	Lot 3 DP612962	Rural / Private	1026	5130	7
6	Lot 2 DP612962	Rural / Private	152	760	1
7	Lot 1 DP612962	Rural / Private	70	350	1

* Excludes Country Energy Easements.

It is considered that the location of the borefields and associated pipelines would have minimal impact on existing land use apart from temporary impacts during construction. The location of the pipeline would lie adjacent to the Nambucca River and South Creek, where possible.

The easement is not expected to result in the severance of any affected properties and would result in a negligible loss of productive agricultural land and therefore there is not expected to be any detrimental affect on the ongoing viability of existing farms.

21.3.3 Consultation

Ongoing communication, consultation and liaison with property owners have ensured they are aware of project developments and timeframes. Throughout the pipeline selection phase and environmental assessment phase of the Proposal, discussions have been held with all directly affected landholders on how to best minimise the impact on the function and amenity of their land. It is acknowledged that there are a few dissenting landowners who are opposed to the Proposal. On-going discussions and negotiations were continuing at the time of writing this EIS. Any acquisition requirements would be negotiated with affected landowners to determine the most amenable arrangement. Compulsory acquisition would only be pursued if satisfactory arrangements can not be reached with the landowner. Impacts on property owners would be clearly identified and discussed with affected landowners during Proposal planning and construction to ensure all residents are aware of the process in order to minimise any physical and emotional impacts on landowners.

21.4 Mitigation Measures

Measures to minimise and or mitigate, as far as is practical, the potential negative effects of the Proposal on land use are outlined below. Specific mitigation measures in relation to the impact of construction activities on adjoining land uses, e.g. dust and noise nuisance, road access changes, are identified in Chapter 7, 12 and 15.

21.4.1 Construction

Construction impacts would be minimised where possible through the development of construction, environmental and traffic management procedures and systems. Some management measures may include:

- Maintaining property access for the duration of construction. The construction contractor would consult with individual landowners would temporary property access be required.
- Providing property owners with advanced notification of project schedules, construction works and changes to access arrangements.
- Separate approvals would be required for construction compounds/ temporary holding yards during the detailed design phase.
- Separate approvals would be required for augmentation of the electricity network to service the Proposal during the detailed design phase.

21.4.2 Operation

- Prior to acquisition of land dedicated under the *Forestry Act 1916*, such as a state forest, revocation of the land in accordance with the Act must first be affected by one, or a combination of the following means:
  - Act of Parliament – where the land affected (irrespective of the area) is zoned by Forests NSW for conservation purposes.
  - Resolution of both Houses of Parliament – where the land affected is not zoned for conservation purposes and exceeds 20 hectares.
  - Notice in the Government Gazette – where the land affected is not zoned for conservation purposes and does not exceed 20 hectares.

- Negotiations with affected landowners for the use of the land (via easements) affected by the borefield collection system, transfer pipeline, access and power augmentation would be undertaken during the detailed design phase.
- Compulsory acquisition of land would only be negotiated with affected landowners if satisfactory arrangements can not be reached and then in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. The objectives of the *Land Acquisition (Just Terms Compensation) Act* are to:
  i. Guarantee that, when land affected by a proposal for acquisition by an authority of the State is eventually acquired, the amount of compensation would be not less than the market value of the land (unaffected by the Proposal) at the date of acquisition.
  ii. Ensure compensation on just terms for the owners of land that is acquired by an authority of the State when the land is not available for public sale.
  iii. Establish procedures for the compulsory acquisition of land by authorities of the State to simplify and expedite the acquisition process.
  iv. Require an authority of the State to acquire land designated for acquisition for a public purpose where hardship is demonstrated.
  v. Encourage the acquisition of land by agreement instead of compulsory process.

LEP Amendments

- The *Nambucca Local Environment Plan 1995* would need to be amended to reflect the change in land use of the Proposal from its current 1(f) Rural (Forestry) zoning to a more appropriate zone such as RU1 Primary Production or SP2 Infrastructure as part of the draft Local Environmental Plan (LEP).
- In order to protect the water quality within the catchment, development on surrounding land would be managed by the *Nambucca Local Environment Plan 1995* or new draft LEP to ensure that water entering the system does not adversely affect water quality. NSC would review water quality protection measures as part of future LEP and DCP amendments. This would include consideration of an overlay linked to local land use provisions.

22 Climate Change and Greenhouse Gases

22.1 Introduction

This Chapter identifies the potential climate change, energy and greenhouse gases impacts associated with the Proposal and the management measures to reduce these impacts. Table 22-1 outlines the Director-General's and other statutory authority requirements and where they have been addressed.

Table 22-1 Statutory Requirements

Statutory Authority	EIS Requirements	Where Addressed
Director-General's requirements (DoP)	◗ The affect of the development or activity on the local climate.	Refer to 22.2, 22.3 and 22.4.
Department of Environment and Climate Change (DECCW) (formerly DECC)	◗ *Climate Change:* intensifications of droughts and sea level rise lions and implications on surface ground water interaction and estuary ecology. ◗ *Greenhouse Emissions:* comprehensive assessment of predicted greenhouse gas emissions, tonnes per unit, total annual emissions and direct and indirect emissions.	Refer to 22.2, 22.3 and 22.4.

22.2 Existing Conditions

22.2.1 Climate Change

It is increasingly clear that our climate is changing at a faster rate than previously experienced. A report by CSIRO and the Bureau of Meteorology in 2004 found that between 1950 and 2003, NSW became 0.9°C warmer, with more hot days/nights and fewer cold days/nights. Annual total rainfall declined by an average of 14 mm per decade, with the largest declines in rainfall near the coast due to an increase in El Niño years since the mid-1970s. Extreme daily rainfall intensity and frequency have also decreased throughout much of the State. It is predicted that the climate would continue to change in the future at an increasingly rapid rate.

The predicted changes in climate have the potential to impact the proposed Bowraville Storage (the Proposal). The following section aims to provide a desktop assessment of the potential impacts from climate change on the Proposal, by:

- Outlining the existing climate conditions;
- Providing details on the climate changes predicted for the area;
- Assessing how these changes may impact on the Proposal; and
- Describing possible options for mitigating these impacts.

The assessment has been based on information provided by NSC, CSIRO, International panel on Climate Change (IPCC), the Commonwealth Department of Climate Change (DCC), NSW Department of Environment, Climate Change and Water (DECCW) and other similarly recognised government bodies. This information has not been independently verified.

Predicted Climate Changes

It is evident that changes in global and regional climate are occurring. The CSIRO and DECCW have produced regional climate change projections under differing greenhouse gas emission scenarios for 2030, 2050 and 2070 which have been used in this assessment. The summary of climate change variables provided below has been referenced from the two main regional NSW government published documents relevant to the study area. The most recent data is the DECCW (2008) *Summary of Climate Change Impacts, North Coast Region, NSW Climate Change Action Plan*, prepared by the University of NSW for DECCW. The second data set is derived from the CSIRO (2007) '*Climate Change in the Northern Rivers Catchment*,' prepared for the NSW Government by CSIRO. Table 22-2 below provides the data as appears for 2030 (CSIRO), 2050 (UNSW) and 2070 (CSIRO), note again that 2050 data is based on the most recent calibrations. The CSIRO projections for rainfall and temperature were updated by UNSW to adjust for rainfall variability, and it is these figures that have been adopted by NSW government.

Table 22-2 Summary of Climate Variables

Climate Variable		Predicted Change		
		CSIRO (2007) 2030	UNSW (2008) 2050	CSIRO (2007) 2070
Temperature	Annual Average Temperature (°C)	+0.2 - +1.8°C (CSIRO Northern Rivers projections)	+1 to +3°C	+0.7 - +5.6°C (CSIRO Northern Rivers projections)
		+0.2 - +2.8°C (CSIRO NSW projections)		+0. - +6.4°C (CSIRO NSW projections)
Summer Temperature	Average	+0.2 to +2.3 °C (CSIRO NSW projections)		+0.7 to + 7.1 °C (CSIRO NSW projections)
	Average Max	Data not available	+1.5 to +2°C	Data not available
	Average Min	Data not available	+2 to +3°C	Data not available
Autumn Temperature	Average	+0.2 to +1.9 °C (CSIRO NSW projections)		+0.7 to +5.6 °C (CSIRO NSW projections)
	Average Max	Data not available	+1.5 to +2°C	Data not available
	Average Min	Data not available	+2 to +3°C	Data not available
Winter Temperature	Average	+0.2 to +2.3 °C (CSIRO NSW projections)		+0.7 to +5.6 °C (CSIRO NSW projections)
	Average Max	Data not available	+2 to +3°C	Data not available
	Average Min	Data not available	+2 to +3°C	Data not available
Spring Temperature	Average	+0.2 to +2.1 °C (CSIRO NSW projections)		+0.7 to +7.1 °C (CSIRO NSW projections)

	Average Max	Data not available	+1.5 to +2°C	Data not available
	Average Min	Data not available	+2 to +3°C	Data not available
Extreme Temperature (CSIRO, data averaged 1964 to 2003)	Annual average number of cold days (below0°C)	Yamba: 0 (CSIRO Northern Rivers projections)	Data not available	Yamba: 0 (CSIRO Northern Rivers projections)
	Annual average number of hot days (over 35°C)	Yamba: 1-2 (CSIRO Northern Rivers projections)	Data not available	Yamba: 1-7 (CSIRO Northern Rivers projections)
	Annual average number of hot days (over 40°C)	Yamba: 0 (CSIRO Northern Rivers projections)	Data not available	Yamba: 0 (CSIRO Northern Rivers projections)
Rainfall	Annual average rainfall	-7 -+7% (CSIRO Northern Rivers projections) -13 to +7 % (CSIRO NSW projections)		- 20 - +20% (CSIRO Northern Rivers projections) -40 to +20 % (CSIRO NSW projections)
Summer Rainfall	Average	-13 to +13 % (CSIRO NSW projections)	-5 to +5 %	-40 to +40 % (CSIRO NSW projections)
Autumn Rainfall	Average	-13 to +13 % (CSIRO NSW projections	-5 to +5 %	-40 to +40 % (CSIRO NSW projections)
Winter Rainfall	Average	-13 to +7 % (CSIRO NSW projections)	-10 to +5 %	-40 to + 20 % (CSIRO NSW projections)
Spring Rainfall	Average	-20 to +7 % (CSIRO NSW projections)	-10 to +5 % [Please note the seasonal rainfall distribution indicates that Tweed may experience a –5 to +5% change, whilst Byron may experience dryer conditions with a change of –10 to +5%]	-60 to + 20 % (CSIRO NSW projections)
	Extreme Rainfall (1 in 40 year 1-day rainfall)	-10-+5% (CSIRO Northern Rivers projections)	Data not available	+5 - +10% (CSIRO Northern Rivers projections)
Run-off	Average Maximum		-10 to 20% in dryer periods	
Summer Run-off	Average		+4 to -15%	
Autumn Run-off	Average		-12 to +16%	
Winter Run-off	Average		-20 to +8%	
Spring Run-off	Average		-14 to +4%	

Evaporation	Annual Average (%)	+1 - +13% (CSIRO Northern Rivers projections)	Data not available	+4 – +40% (CSIRO Northern Rivers projections)
Number of droughts per decade (CSRIO, centred on 1990 data)		2-4 (CSIRO Northern Rivers projections)	Data not available	1-9 (CSIRO Northern Rivers projections)
Wind Speed	Average Annual Wind Speed (%) 50th percentile	-2 to +2%	Data not available	+2 to +5%
Extreme Wind		-5 to +8 % (CSIRO Northern Rivers projections)	Data not available	-16 to +24% (CSIRO Northern Rivers projections)
Relative Humidity	Summer Average (%) 50th percentile	-0.5 to +0.5%	Data not available	0.5 to –1%
Number of Fire days		Coffs Harbour: 5 - 6 (CSIRO Northern Rivers projections)	10 to 15	Coffs Harbour: 5 - 8 (CSIRO Northern Rivers projections)
Downward Solar Radiation	Summer Average (%) 50th percentile	-1 to +1%	Data not available %	-1 to +1%
Sea Level Rise	Above 1990 base line		+40cm	+90cm (by 2100, UNSW data and level adopted by NSW Govt)
Sea Surface Temperature Change	Average (°C)	+0.3 to +0.6 °C		+1.5 to +2 °C

Table Table 22-3 shows the projected average year and dry year demands including impacts of climate change.

Table 22-3 Projected Average Year and Dry Year Demands

Scenario 3

Projected Demand (ML)		2006	2011	2016	2021	2026	2031	2036	2041	2046
Scenario 3 - Av Year	Connected	1,527	1,468	1,487	1,726	1,909	2,038	2,153	2,194	2,215
	Unconnected	57	57	58	59	59	60	61	62	63
	Losses	292	271	296	334	368	393	418	427	436
	Total	1,875	1,796	1,840	2,119	2,337	2,491	2,633	2,673	2,714
Scenario 3 - Dry Year	Connected	1,738	1,739	1,840	2,097	2,167	2,287	2,400	2,432	2,464
	Unconnected	94	95	96	97	99	100	102	104	105
	Losses	292	271	296	334	368	393	418	427	436
	Total	2,124	2,106	2,232	2,438	2,634	2,781	2,920	2,963	3,006
Scenario 3 - CC 2050 (Av Year)	Connected	1,603	1,587	1,663	1,843	2,012	2,138	2,256	2,288	2,320
	Unconnected	60	60	61	62	63	64	66	66	67
	Losses	292	271	296	334	368	393	418	427	436
	Total	1,955	1,919	2,020	2,240	2,443	2,595	2,739	2,781	2,823
Scenario 3 - CC 2050 (Dry Year)	Connected	1,904	1,919	2,040	2,215	2,384	2,510	2,629	2,664	2,700
	Unconnected	108	109	110	112	114	115	117	119	121
	Losses	292	271	296	334	368	393	418	427	436
	Total	2,304	2,300	2,446	2,661	2,866	3,018	3,164	3,210	3,256

The above demands reflect the significant impacts that climate change would have on the demand for water. The above figures have been factored into the analysis as part of the IWCM Strategy and ultimately the design of the Proposal. As previously indicated, the existing Nambucca and District Water Supply Scheme is highly vulnerable to drought. Given the expected changes in climate and the likelihood of longer drought periods, an increased level of drought security is critical for the Nambucca LGA together with additional demand management strategies outlined in the IWCM Strategy,

22.2.2 Greenhouse Gas

Methodology

The greenhouse gas assessment was prepared in accordance with the general principles of:

- The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard developed by the World Business NSC for Sustainable Development (GHG Protocol);
- Life Cycle Assessment principles (ISO 14040 series);
- The Commonwealth Department of Climate Change (DCC) National Greenhouse Accounts (NGA) Factors, June 2009;
- The Australian Government Full Carbon Accounting Model (FullCAM); and
- Department of Planning's Draft Guidelines *Energy and Greenhouse in EIA,* August 2002.

These are considered to represent current good practice in Australian greenhouse gas accounting.

Emission Scopes

Emissions have been separated into scopes 1, 2 and 3, in accordance with the Greenhouse Gas Protocol. These scopes are defined as follows:

- Scope 1 emissions are greenhouse gas emissions created directly by a person or business from sources that are owned or controlled by that person or business.
- Scope 2 emissions are greenhouse gas emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business who consumes the electricity.
- Scope 3 emissions are greenhouse gas emissions that are generated in the wider economy as a consequence of a person's or business's activities. These are indirect emissions as they arise from sources that are not owned or controlled by that person or business but they exclude Scope 2.

Scope 1 emissions are produced by the combustion of fuels such as diesel at the development site, and by vehicles and plant equipment which the Proponent owns and has operational control over. Emissions associated with vegetation removal and inundation are also considered Scope 1 emissions. Note that only the direct combustion of the fuels is considered as Scope 1. Scope 2 emissions arise from the consumption of electricity at the development site, in plant equipment that is owned and operated by the Proponent. Emissions arising from the extraction, processing and transportation and distribution of fuels and electricity are classified as Scope 3, since these activities are not within the operational control of the end user.

All other emissions associated with the Proposal are defined as Scope 3, since they are produced outside the development site, and the Proponent does not have operational control of the facilities from which they originate. The Proponent does not own or operate any of the vehicles that transport raw materials to the site. As such, the emissions resulting from the combustion of fuels for this transportation are classified as Scope 3.

22.3 Impact Assessment

22.3.1 Climate Change

Climate change may affect the Proposal through primary changes in the climate variables and secondary changes in the frequency and intensity of extreme events. Severe weather events, storm surges, changing patterns and intensity of cyclones, increased bushfire hazard, along with rising sea level and sustained heat waves are likely to have significant impact on the region. Prolonged instances of heat, wind and rainfall, and increased variations in these phenomena, can also lead to greater stratification of water within the storage, accelerated structural fatigue and greater demands on construction. The impacts of climate change on the Proposal's feasibility has been considered in the IWCM Strategy (NSW WS, 2009).

Assessments of the main impacts these phenomena may have on the Proposal are presented below. Measures to mitigate the impacts identified are also provided. In making a decision regarding mitigation measures, it is advised that scientific evidence has observed carbon dioxide concentration; global mean temperatures and sea level rise tracking at the upper end of the IPCC scenario range from 1990 to 2006. Additionally, the CSIRO advises that the mid and low projections may be less likely than the high projections, with significant implications for risk management (CSIRO, 2007).

Impacts on Water Availability

According to DECCW (2008), there would more likely than not be a slight increase in average annual runoff and stream flow for the North Coast. Runoff is likely to increase in summer and autumn and decrease in winter and spring. The amplification of El Nino and La Nina events would also influence water availability. El Niño years are likely to continue to be drier than average and La Niña years are likely to continue to be wetter than average.

Water availability may influence extraction periods and the required capacity of the Proposal. In La Nina years it would be expected that extraction would be viable but during El Nino years opportunities for extraction would be expected to be limited. Also the greatest demand on the Proposal would be expected during the El Nino years due to the dry conditions. The Proposal would need to have a sufficient volume to accommodate this demand if the El Nino persists for a prolonged period. Warmer temperatures and increased solar radiation are also likely to increase water loss from the Proposal via evaporation and therefore additional extraction and/or larger storage in the longer term may be required.

The increase in extreme rainfall events would also be considered because they would periodically deliver large volumes of water to the Proposal, possibly making the effect of long term reductions in average rainfall on the Proposal moderate. However, extreme rainfall events would limit the times when water can be extracted from the river due to poor water quality (high turbidity). Elevated nutrient during these conditions might also restrict the taking of water into the storage.

High rainfall events are also associated with an increased pathogen risk and hence a change in the frequency or seasonal distribution of such events may increase the risks posed by pathogen contamination at the storage.

Impacts on Water Quality

Climate change is likely to have several impacts on water quality. Potentially the most significant is sea level rise. The sea level is predicted to rise due to the melting of glaciers and ice caps and thermal expansion of the oceans. DECCW (2008) predict that sea level along the North Coast of NSW would rise up to 40 cm above 1990 levels by 2050 and 90 cm by 2100. This may impact on groundwater in low-lying coastal floodplains leading to potential increases in infiltration of saline water into coastal aquifers (CSIRO, 2007). Any increase or migration of the salinity concentrations caused by climate change may impact on the Proposal because the existing borefields are located close to the extent of the current tidal range. This impact may be further exacerbated by increased extraction rates as a result of the Proposal and if surface runoff decreases as predicted as this could draw saline water further inland than currently experienced.

Increases in air temperature would be reflected by increases in water temperature, with the following potential consequences:

- Increases in the duration and intensity of thermal stratification within the storage.
- Changes in the timing of the onset of stratification.
- Altered biota composition both within the Nambucca River and storage. For example, the length of the potential growing season of nuisance algal blooms may be extended.
- Changed chemical composition of the inflow and storage water including decreased dissolved oxygen concentrations.
- Increased chemical reaction rates which would impact on the treatment process, in particular chlorine demand and disinfection by-product formation within the distribution system (Water Quality Research Australia, 2008).

There is the potential for higher nutrients to enter the Storage due to the predicted increase of bushfire as a result of climate change. The Bowra Creek catchment is vulnerable to bushfire attack due to the dense cover of vegetation surrounding the proposed storage area. This may cause increased sediment and ash runoff that is loaded in nutrients entering the storage. The more intense rain events predicted may also contribute to erosion of the steep Bowra Creek catchment and sedimentation of the storage.

Impacts on Infrastructure

CSIRO, et al (2007) have suggested that the predicted drier conditions, increased ground movement and changes in groundwater could accelerate degradation of materials and structural integrity of water supply pipelines. The Proposal includes a significant length of underground piping that may be subject to these phenomena, so this impact would be considered. Higher temperatures may also have an impact on the infrastructure.

22.3.2 Greenhouse Gas

Level of Assessment Required

The Department of Planning's Draft Guidelines *Energy and Greenhouse in EIA* (Guidelines) indicate two possible levels of assessment:

- Level 1 Assessment – A simplified assessment based on a limited number of energy sources and methane generation potential; and
- Level 2 Assessment – A more detailed assessment including all Scope 1 and 2 emissions and 'upstream' and 'downstream' emissions.

DECCW require a "*comprehensive assessment*" and the inclusion of "*direct emissions, indirect emissions (e.g. those associated with electricity use) and any significant upstream and/or downstream emissions associated with the Proposal*". These requirements imply that a Level 2 assessment is required.

Boundary of the Assessment

System Boundary

The system boundary is the inputs and outputs of each of the identified life cycle stages, including transportation and support services. This includes the manufacture of products and raw materials, the use of energy and utilities and the treatment of solid, liquid and gaseous wastes generated.

The life cycle stages for the Proposal are:

- Raw materials – Embodied energy in each of the major construction raw materials;
- Delivery of raw materials and equipment to site;
- Construction of infrastructure – energy consumption by equipment during construction activities, removal of vegetation and disposal of construction waste materials;
- Operation – electricity consumption by pumps and aerators during the extraction, storage and distribution of water; and
- Decommissioning – Emissions associated with eventual infrastructure decommissioning.

The system boundary is depicted in Figure 22-1.

Aspects of Energy Use Considered

The following aspects of energy use have been considered for the products:

- Energy required to extract, process and manufacture construction materials;
- Energy required for construction activities;
- Energy required for extraction and distribution of water; and
- Energy used to dispose or recycle waste products from each life cycle stage.

Greenhouse Gases Considered

The greenhouse gases considered in this assessment are:

- Carbon dioxide;
- Nitrous oxide; and

- Methane.

The development is unlikely to store, generate or use any perfluorocarbons and sulphur hexafluoride and uses negligible quantities of hydrofluorocarbons for refrigeration and air conditioning during construction. These gases have therefore been excluded from the assessment.

Construction Materials

Emissions associated with the extraction and processing of construction materials from their point of production to the site.

- Backfill
- Bitumen
- Cables (major)
- Concrete
- Gravel/rip rap
- Pipes (iron and cement)
- Pumps (stainless steel and iron)
- PVC (conduit and pipes)
- Sand
- Steel
- Construction vehicle maintenance materials (oil/lubricants)
- Construction vehicles and equipment
- Materials for electricity distribution infrastructure
- Materials for minor construction items (minor cables and associated electrical equipment, flanges etc)
- Water

→

Transport of Construction Materials to Site

Emissions associated with the transportation of raw materials from their point of production to the site.

- Backfill
- Bitumen
- Cables (major)
- Concrete
- Diesel
- Gravel/rip rap
- Pipes (iron and cement)
- Pumps (stainless steel and iron)
- PVC (conduit and pipes)
- Sand
- Steel
- Waste to landfill
- Construction vehicle maintenance materials (oil/lubricants)
- Construction vehicles and equipment
- Materials for electricity distribution infrastructure
- Materials for minor construction items (minor cables and associated electrical equipment, flanges etc)
- Water

→

Construction Activities

Emissions associated with the construction activities.

- Diesel (construction vehicle and generators)
- Electricity (site offices)
- Waste disposal in landfill
- Vegetation clearance
- Fugitive emissions due to inundation
- Petrol consumption by workers travelling to site
- Wastewater treatment
- Re-vegetation activities
- Onsite refuelling infrastructure and fugitive emissions.

→

Items in blue have been excluded from the assessment.

Figure 22-1 System Boundary for the Proposal

Data Collection and Calculation Procedures

Emission factors that are used in the greenhouse footprint calculations are shown in Table 22-5 and Table 22-6. Where possible, factors have been sourced from the *National Greenhouse Accounts (NGA) Factors, June* 2009. If factors have been sourced elsewhere then source references have been provided in Table 22-4.

Wherever possible, estimates with high confidence were used to calculate greenhouse gas emissions. For example, electricity consumption estimates can be multiplied by the NGA emission factors to calculate greenhouse gas emissions with a high degree of accuracy. When data is unavailable, assumptions and approximations were made in order to obtain a reasonable estimate. For example, emissions factors for some of the equipment were not readily available, and these were estimated based on the best available information. Recognised standards, such as the World Business NSC Greenhouse Gas Protocol, were used to assist in these estimations whenever appropriate. All assumptions are detailed in Table 22-4.

Two approaches were used to estimate the GHG emissions from land sources that would be converted to permanently flooded land following the completion of the Proposal. The assessment also considered emissions from vegetation clearance associated with the construction of the storage embankment. GHG emissions are for all emissions associated with the Proposal irrespective of who undertakes clearance activities.

Two approaches were used to estimate the emissions from flooded land:

- FullCAM was used to establish current carbon stocks within the inundation zone of the Proposal and the emissions associated with the removal/inundation of this biomass; and
- IPCC tier 1 algorithms for both carbon dioxide (CO_2) and methane (CH_4) emissions.

All energy consumption and emissions data has been converted into quantities of carbon dioxide equivalent for each life cycle stage of the Proposal. The emission values for each life cycle stage have been summed to reach an estimate of the total greenhouse gas emissions over the entire life cycle.

Exclusions and Assumptions

Exclusions

Exclusions from the GHG assessment are:

- Emissions associated with the manufacturing of construction vehicles and equipment and their transportation to site. The construction period was considered minimal when compared to the life of the capital equipment required for construction activities such as excavators, dozers, trucks and cranes. Therefore, construction equipment is not manufactured primarily for this Proposal and hence the emissions associated with manufacturing are not included. The emissions from use of the construction equipment were included.
- Emissions associated with on-site refuelling infrastructure. It is understood that the re-fuelling infrastructure comprises a mobile plant. The emissions associated with the transportation and construction of the refuelling infrastructure and the fugitive emissions from fuel storage and refuelling activities were excluded.

- Emissions associated with infrastructure for electricity distribution onsite (lines, transformers etc). These items were considered negligible compared to the overall construction activity emissions.
- Emissions associated with minor construction items and materials such as minor cabling and associated electrical equipment, and rubber rings or flanges (if used) for pipe connections. These items were considered negligible compared to the overall construction activity emissions.
- Emissions associated with the consumption, treatment and disposal of water and wastewater during construction. These items were considered negligible compared to the overall construction activity emissions.
- Emissions associated with the transportation of harvested vegetation from the site. It was assumed that vegetation would be mulched and re-used on site. The transportation of vegetation from the site for re-use in the local region is considered to be minor and therefore was excluded.
- Emissions associated with the maintenance of construction equipment and vehicles and the use of oils, grease, lubricants and replacement parts. These items were considered negligible compared to the overall construction activity emissions.
- Emissions associated with establishing and maintaining vegetation planted after construction. Vegetation maintenance such as seedling growth, transportation to site, fertilisation and water use, weather protection measures and mulching were considered negligible compared to the overall construction activity emissions.
- Emissions associated with the general maintenance of the infrastructure during operation. The emissions associated with general maintenance were considered low compared with anticipated electricity consumption and were therefore excluded.
- Emissions associated with decommissioning. Details of decommissioning procedures were not available at the time of the assessment. It was assumed that the infrastructure would be made safe and remain in place would operations cease in 100 years. The emissions associated with the decommissioning of minor items, such as pumps and valves are unlikely to be significant when annualised over the operating life of the infrastructure and were therefore excluded.

The discrepancies in the total emissions inventory due to the exclusions and limitations of the assessment are anticipated to be minor.

Assumptions

Assumptions used in estimating the activity levels and associated greenhouse gas emissions for the development are listed in Table 22-4 below.

Table 22-4 Greenhouse gas assessment assumptions for Proposal

Parameter measured	Assumptions
Materials	
Backfill material	Quantity estimated as 5,300 t, based on a bulk volume of 2,628 m^3 and a bulk density of 2,000 kg/m^3. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. The emissions factor (EF) was assumed to be similar to the EF for sand. EF sourced from SimaPro based on Australian data for sand from river.
Bitumen	Quantity estimated as 20 m^3, based on an application area of 10,721 m^2 and an application rate of 1.6 L/m^2. Quantity was rounded upwards to one significant figure to obtain a conservative estimate for the GHG assessment. The density of bitumen was assumed to be 1,016 kg/m^3. EF sourced from SimaPro based on Australian data for bitumen.
Cables	Quantity estimated as: • 5,000 m of 16 mm^2 four core and earth copper/PVC cable, mass 98 kg/100 m; • 90 m of 630 mm^2 single core copper/PVC cable, mass 653 kg/100 m; • 90 m of 70 mm^2 single core copper/PVC cable, mass 77 kg/100 m; and • 30 m of 16 mm^2 single core copper/PVC cable, mass 20.8 kg/100 m. Copper mass, based on a density of 8,930 kg/m^3 was estimated as 3,800 kg and PVC mass (by difference) was estimated as 1,900 kg. Quantities were rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. The EFs for the cable raw materials were used as an approximation for the manufactured cable. Copper EF was sourced from SimaPro based on Australian data for copper. PVC EF was sourced from SimaPro based on Australian data for PVC.
Concrete	Quantity of concrete for the inlet/outlet tower, spillway, pipe encasement, thrust blocks and borehole pits estimated as 9,500 t, based on a volume of 3,948 m^3 and a density of 2,400 kg/m^3. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. EF was sourced from SimaPro based on Australian data for ready mix concrete.

Parameter measured	Assumptions
Ductile iron cement lined (DICL) pipes	Quantity of DICL pipe estimated as: • 530 m of DN150; • 580 m of DN200; • 530 m of DN250; • 1,810 m of DN300; • 450 m of DN375; • 600 m of DN400; • 2,488 m of DN600; and • 209 m of DN1000. Mass of iron estimated as 500 t and mass of cement estimated as 200 t, based on Tyton 2100 series PN 20 DICL pipes. Where pipe masses were not available, the mass was extrapolated based on available data and assuming a second order polynomial relationship between diameter and mass. Quantities were rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. The EFs for the pipe raw materials were used as an approximation for the manufactured pipe. Iron EF was sourced from SimaPro based on Australian data for iron. Cement EF was sourced from SimaPro based on Australian data for Portland cement.
Gravel and rip rap	Rip rap was assumed to be similar to gravel for the purpose of the GHG assessment. Quantity estimated as 12,000 t based on a bulk volume 22,847 m^3 and a bulk density of 1,522 kg/m^3. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. EF was sourced from SimaPro based on Australian data for gravel.
Iron (raw water pumps)	Mass of raw water pumps estimate as 6,500 kg, based on 4 Grundfos HS 300-250-305 5/1-F-A BBVP pumps. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. It was assumed that pumps were 100% iron. EF was sourced from SimaPro based on Australian data for iron.
PVC (pipes and conduits)	Quantity estimated as 20 t based on: • 5,000 m of 100 mm heavy duty conduit, mass 3.25 kg/m; and • 718 m of 100 mm diameter PVC pipe, mass 1.73 kg/m. Quantity was rounded upwards to one significant figure to obtain a conservative estimate for the GHG assessment. PVC EF was sourced from SimaPro based on Australian data for PVC.
Sand	Quantity estimated as 47,000 t based on a bulk volume of 23,331 m^3 and a bulk density of 2,000 kg/m^3. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. EF sourced from SimaPro based on Australian data for sand from river.
Stainless steel (borefield pumps)	Mass of borefield pumps estimate as 2,000 kg, based on 9 Grundfos SP60-6 and 15 Grundfos SP95-4 pumps. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. It was assumed that pumps were 100% stainless steel. EF was sourced from SimaPro based on Australian data for 316 stainless steel.

Parameter measured	Assumptions
Steel	Quantity estimated as 7,200 kg for steel lids to bore pump pit covers. EF sourced from SimaPro based on Australian data for steel with a 10% recycled content.
Transportation of materials to site[1]	
Backfill material	It was assumed that the backfill material would be sourced from suppliers in Nambucca Heads, NSW and transported by rigid truck.
Bitumen	It was assumed that bitumen would be sourced from suppliers in Kurnell, NSW and transported by rigid truck.
Cables	It was assumed that cables would be sourced from suppliers in Liverpool, NSW and transported by rigid truck.
Concrete	It was assumed that concrete would be sourced from suppliers in Liverpool, NSW and transported by rigid truck.
Diesel	It was assumed that bitumen would be sourced from suppliers in Kurnell, NSW and transported by rigid truck.
Ductile iron cement lined pipes	It was assumed that pipes would be sourced from suppliers in Somerton, Vic and transported by rigid truck.
Gravel and rip rap	It was assumed that gravel and rip rap would be sourced from suppliers in Valla, NSW and transported by rigid truck.
Pumps (raw water and borefield)	It was assumed that pumps would be sourced from suppliers in Denmark and transported between Aarhus and Sydney by ship and then by rigid truck to site. Shipping distances have been estimated using the website http://www.portworld.com/map/. Shipping EF sourced from SimaPro based on Australian data for international shipping.
PVC pipes and conduits	It was assumed that PVC pipe and conduit would be sourced from suppliers in Chipping Norton, NSW and transported by rigid truck.
Sand	It was assumed that sand would be sourced from suppliers in Raleigh, NSW and transported by rigid truck.
Waste to landfill	It was assumed that waste would be disposed of in Coffs Harbour, NSW and transported by rigid truck.
Construction activities	

[1] Unless otherwise stated, road distances have been estimated using the website http://www.whereis.com and rigid truck EF sourced from SimaPro and is based on Australian data for rigid trucks. Distances are based on the manufacturing or extraction location.

Parameter measured	Assumptions
Diesel consumption by construction vehicles	The quantity of diesel consumed by construction equipment was estimated as 3,200 kL using Brake Specific Fuel Consumption data reported in US EPA's report *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, Report No. NR-009c (2004)*. The hours of use for each construction vehicle/equipment was estimated based on 9 h per day, 23 days per month and an utilisation factor that varied depending on the vehicle. The number of months for each vehicle/equipment was estimated and varied between 2 to 12 months. The net power for each vehicle/equipment was obtained from manufacturer vehicle specifications, where the model to be used was known, or estimated based on similar vehicles. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. EF from Tables 4 and 38 of the DCC NGA Factors (June 2009) for diesel (Scopes 1 and 3).
Diesel consumption in generators	The quantity of diesel consumed by generators was estimated using Brake Specific Fuel Consumption data reported in US EPA's report *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition, Report No. NR-009c (2004)*. The hours of use were estimated based on operation of 2 generators intermittently for up to 12 months and a power rating of 3.3 kVA. Total quantity of diesel consumed by generators estimated as 400 L. Quantity was rounded upwards to one significant figure to obtain a conservative estimate for the GHG assessment. EF from Tables 3 and 38 of the DCC NGA Factors (June 2009) for diesel (Scopes 1 and 3).

Parameter measured	Assumptions
Site office electricity consumption	Quantity estimated as 23,700 kWh based on a site office containing lighting, heating, computers, microwave, hot water, refrigerator and miscellaneous electrical equipment and in use for 300 days. Electricity sourced from grid. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. EF from Table 39 of the DCC NGA Factors (June 2009) for NSW and ACT (Scopes 2 and 3.
Vegetation removal (storage embankment)	It was assumed that the vegetation would be re-used in the local region and none of the vegetation would be burnt or disposed of in landfill. FullCAM modelling was based on the removal of the following vegetation: ◗ Hardwood Plantation Forest – 1.26 ha ◗ Foothills Grey Gum – Broad-leaved Mahogany Forest – 3.02 ha The modelling scenario was for the area of affected forest to be cleared for construction. The following assumptions on emissions were made; ◗ Removal of all biomass – all biomass would be removed from site and the site excavated down to bed rock. As a result all carbon pools, including trees, debris and soil are moved off site and are assumed to be emitted; ◗ Pastureland and riparian vegetation have not been included in the greenhouse gas emission calculations because they are not classified as forest. Prior to clearance it is estimated that there would be 133.25 t C/ha in the hardwood plantation and 199.61 t C/ha in native forest (including trees, debris and soil pools). Clearing this vegetation down to bed rock would result in emissions of 2,829 t CO_2-e.

Parameter measured	Assumptions
Vegetation removal (catchment inundation area)	It was assumed that the vegetation would be re-used in the local region and none of the vegetation would be burnt or disposed of in landfill. FullCAM modelling was based on the removal of the following vegetation: ◗ Hardwood Plantation Forest - 25.94 ha ◗ Wet Flooded Gum – Tallowwood Forest - 20.02 ha ◗ Northern Wet Tallowwood – Blue Gum Forest - 7.85 ha ◗ Foothills Grey Gum – Broad-leaved Mahogany Forest - 4.14 ha ◗ Wet Bloodwood – Tallowwood Forest (Temperate Rainforest) - 0.64 ha The modelling scenario was based on: ◗ a mature forest growing across the catchment with the *Eucalyptus grandis* plantation in a late growth phase after being established in 1974; ◗ the entire area to be affected by inundation would be salvage logged; and ◗ the site is then inundated. The following assumptions on emissions were made: ◗ Variability in forest biomass across the catchment – To gain an understanding of the spatial variability in forest biomass across the catchment, six points were sampled within the National Carbon Accounting System maximum above ground biomass surface using FullCAM. Little variability was found across the catchment. On the basis of this finding all the indigenous forest types were combined to model as one category and the hardwood plantation was modelled separately as *Eucalyptus grandis*. ◗ Salvage logging – It was assumed that the carbon in the biomass taken offsite during salvage logging would be immediately emitted. These emissions are reported because the land is being converted to a non-forest land use and hence a deforestation event would occur. According to convention, the carbon held in the harvested wood products is not reported; ◗ Metabolism of labile carbon pools following inundation – The labile carbon pools are the most likely carbon pools to be metabolised and emitted as CO_2-e. It is unclear what proportion of this might go to methane (CH_4) so it has been assumed as zero at this stage. There is no timeframe on these emissions as they would occur at some stage following the creation of the reservoir. For the purpose of this assessment it was assumed that these emissions are released at the time of deforestation. It was assumed that the woody coarse roots and any large branches remaining onsite would not readily metabolise (note the tree trunks and branches still standing in the snowy-hydro reservoirs); and Labile carbon pools were assumed to be: ◗ Debris – the decomposable components of; dead wood, bark litter, leaf litter, coarse dead roots, and fine dead roots (note that the 'resistant' components of these are assumed to be non-labile); ◗ Soil – decomposable plant matter and fast decomposable plant matter.
Waste disposal in landfill	Quantity estimated as 500 kg. EF sourced from Table 42 of the DCC NGA Factors (June 2009) for construction and demolition waste.

Parameter measured	Assumptions
Workers travelling to site (petrol consumption)	Quantity estimated as 50 kL based on workers travelling separately in passenger vehicles, with fuel consumption of 0.113 L/km, sourced from Table 4, AGO Factors and Methods Workbook, December 2006. The number of workers and duration assumed is outlined below. The total number of days was based on 300 working days per year. • Storage – 60 workers, 12 month duration; • Pipeline – 8 workers, 3 month duration; • Bores – 10 workers, 6 month duration; and • Pumps – 10 workers, 4 month duration. Quantity was rounded upwards to one significant figure to obtain a conservative estimate for the GHG assessment. It was assumed all workers would be situated in the Nambucca region for the duration of the Proposal and a 20 km round trip would be taken each day. EF from Tables 4 and 38 of the DCC NGA Factors (June 2009) for petrol (Scopes 1 and 3).
Operations	
Electricity consumption	Quantity estimated as: • 440,000 kWh/a for the borefield pumps; • 250,000 kWh/a for the raw water pumps; and • 7,000 kWh/a for the aerators. Quantity was rounded upwards to two significant figures to obtain a conservative estimate for the GHG assessment. EF from Table 39 of the DCC NGA Factors (June 2009) for NSW and ACT (Scopes 2 and 3.

Table 22-5 Construction Greenhouse Gas Inventory

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
Materials														
Backfill material	5,300	t			0.02	0.02	t CO_2-e/t	SimaPro Australian Database	Q x EF	0	0	90	90	0.2%
Bitumen	20	m3			0.43	0.43	t CO_2-e/m3	SimaPro Australian Database	Q x EF	0	0	9	9	0.0%
Cement component of pipes	200	t			0.80	0.80	t CO_2-e/t	SimaPro Australian Database	Q x EF	0	0	161	161	0.4%
Concrete	9,500	t			0.14	0.14	t CO_2-e/t	SimaPro Australian Database	Q x EF	0	0	1,340	1,340	3.2%
Copper component in cables	3,800	kg			5.52	5.52	kg CO2-e/kg	SimaPro Australian Database	Q x EF/1000	0	0	21	21	0.1%
Gravel and rip rap	35,000	t			0.02	0.02	t CO_2-e/t	SimaPro Australian Database	Q x EF	0	0	592	592	1.4%
Iron (raw water pumps)	6,500	kg			1.18	1.18	kg CO2-e/kg	SimaPro Australian Database	Q x EF/1000	0	0	8	8	0.0%
Iron	500	t			1.18	1.18	t CO_2-e/t	SimaPro	Q x EF	0	0	590	590	1.4%

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
component of pipes								Australian Database						
PVC in cables	1,900	kg			2.41	2.41	kg CO2e/kg	SimaPro Australian Database	Q x EF/1000	0	0	5	5	0.0%
PVC pipes/conduits	20	t			3.14	3.14	t CO_2-e/t	Industry data 2.0	Q x EF	0	0	63	63	0.2%
Sand	47,000	t			0.02	0.02	t CO_2-e/t	SimaPro Australian Database	Q x EF	0	0	794	794	1.9%
Stainless steel (bore pumps)	2,000	kg			4.02	4.02	kg CO2e/kg	IDEMAT	Q x EF/1000	0	0	8	8	0.0%
Steel	7,200	kg			2.07	2.07	t CO2-e/t	SimaPro Australian Database	Q x EF / 1000	0	0	15	15	0.0%
Total Materials										**0**	**0**	**3,693**	**3,693**	**8.8%**
Transportation of materials to and from site														
Backfill material	5,300	t			9	9	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	49	49	0.1%
Bitumen	20	t			258	258	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	5	5	0.0%
Cables	5,700	kg			245	245	kg CO_2-	Materials	Q x EF /	0	0	1	1	0.0%

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
							e/t	Delivery Worksheet	1000000					
Concrete	9,500	t			6	6	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	61	61	0.1%
DICL pipes	700	t			651	651	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	456	456	1.1%
Diesel	3,200	t			258	258	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	825	825	2.0%
Gravel	35,000	t			14	14	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	480	480	1.1%
Pumps	8,500	kg			360	360	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000000	0	0	3	3	0.0%
PVC pipes/conduits	20	t			246	246	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	5	5	0.0%
Steel	7,200	kg			168	168	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000000	0	0	1	1	0.0%
Sand	47,000	t			20	20	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000	0	0	921	921	2.2%

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
Waste disposal in landfill	500	kg			31	31	kg CO_2-e/t	Materials Delivery Worksheet	Q x EF / 1000000	0	0	0	0	0.0%
Total Materials Transportation										**0**	**0**	**2,807**	**2,807**	**6.7%**
Construction activities														
Diesel consumption by construction equipment	3,200	kL	2.7		0.2	2.9	t CO_2-e/kL	NGA Factors June 2009	Q x EF	8,634	0	655	9,289	22.2%
Diesel consumption by generators	400	L	2.7		0.2	2.9	t CO_2-e/kL	NGA Factors June 2009	Q x EF	1	0	0	1	0.0%
Site office electricity consumption	23,700	kWh		0.89	0.18	1.1	kg CO_2-e/kWh	NGA Factors June 2009	Q x EF / 1000	0	21	4	25	0.1%
Vegetation removal - catchment inundation area	Refer to Table 7 and 9									22,996	0	0	22,996	55.1%
Vegetation removal - storage embankment and associated infrastructure	Refer to Table 11									2,829	0	0	2,829	6.8%

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
Waste disposal in landfill	500	kg			0.3	0.3	t CO_2-e/t	NGA Factors June 2009	Q x EF / 1000	0	0	0	0	0.0%
Workers travel to site (petrol consumption)	50	kL			2.5	2.5	t CO_2-e/kL	NGA Factors June 2009	Q x EF	0	0	123	123	0.3%
Total Construction										***34,460***	***21***	***783***	***35,264***	***84.4%***
Total emissions for construction period										**34,460**	**21**	**7,283**	**41,765**	

Table 22-6 Annual Operational Greenhouse Gas Inventory

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
Operations														
Borefield Pumps	440,000	kWh/a		0.89	0.18	1.07	kg CO_2-e/kWh	NGA Factors June 2009	Q x EF/1000	0	392	79	471	63.1%
Raw water pumps	250,000	kWh/a		0.89	0.18	1.07	kg CO_2-	NGA Factors	Q x EF/1000	0	223	45	268	35.9%

Component	Value (Q)	Units	Scope 1 Emission Factor (EF)	Scope 2 Emission Factor (EF)	Scope 3 Emission Factor (EF)	Total Emission Factor (EF)	Units	Source	Method	Scope 1 Emissions (t CO_2-e)	Scope 2 Emissions (t CO_2-e)	Scope 3 Emissions (t CO_2-e)	Total Emissions (t CO_2-e)	Proportion of Total Inventory %
							e/kWh	June 2009						
Aerators	7,000	kWh/a		0.89	0.18	1.07	kg CO_2-e/kWh	NGA Factors June 2009	Q x EF/1000	0	6	1	7	1.0%
Total annual operational emissions										**0**	**620**	**125**	**746**	

Emissions associated with vegetation removal

The modelling scenario and assumptions for emissions associated with vegetation removal are detailed in Table 22-4. Detailed results of the assessment are detailed below:

Catchment Inundation Area

Emissions associated with salvage logging are presented in Table 22-7.

Table 22-7 Biomass removed and emissions associated with salvage logging

Vegetation Community	Area (ha)	Carbon density removed (t C/ha)	Carbon mass removed (t C)	Emissions associated with salvage logging (t CO_2-e)
Hardwood Plantation Forest	25.94	71.7	1,861	6,831
Wet Flooded Gum – Tallowwood Forest	20.02	113	2,262	8,302
Northern Wet Tallowwood – Blue Gum Forest	7.85	113	887	3,255
Foothills Grey Gum – Broad-leaved Mahogany Forest	4.14	113	468	1,717
Wet Bloodwood – Tallowwood Forest (Temperate Rainforest)	0.64	113	72	265
Sub total native vegetation	32.7		3,689	13,540
Total	**58.6**		**5,551**	**20,371**

The labile carbon stocks remaining onsite following the salvage logging operation are presented in Table 22-8.

Table 22-8 Density of labile carbon stocks following salvage logging

Vegetation Community	Labile components of debris carbon (tC/ha)	Labile components of soil carbon (tC/ha)	Total (tC/ha)
Hardwood Plantation Forest	9.84	0.29	10.13
Native Forest	13.71	0.15	13.86

Emissions associated with the decay of the labile carbon pools is presented in Table 22-9.

Table 22-9 Carbon stock and emissions associated with labile carbon pools

Vegetation Community	Area (ha)	Carbon density in labile pools (t C/ha)	Total carbon mass of labile pools (t C)	Emissions associated with decay of labile pools (t CO_2-e)
Hardwood Plantation	25.94	10.13	263	964

Vegetation Community	Area (ha)	Carbon density in labile pools (t C/ha)	Total carbon mass of labile pools (t C)	Emissions associated with decay of labile pools (t CO_2-e)
Forest				
Wet Flooded Gum – Tallowwood Forest	20.02	13.86	277	1,018
Northern Wet Tallowwood – Blue Gum Forest	7.85	13.86	109	399
Foothills Grey Gum – Broad-leaved Mahogany Forest	4.14	13.86	57	211
Wet Bloodwood – Tallowwood Forest (Temperate Rainforest)	0.64	13.86	9	33
Total Native	32.7		453	1,661
Total	**58.6**		**715**	**2,625**

The largest source of emissions is the Wet Flooded Gum – Tallowwood Forest. This vegetation community covers approximately 34% of the area and results in approximately 40% of the emissions. The four indigenous vegetation communities account for 56% of the total area and 66% of the total emissions. This is because the t C/ha of labile carbon are higher in the indigenous vegetation communities.

Storage Embankment and associated infrastructure

FullCAM modelling was based on the vegetation listed in Table 22-10.

Table 22-10 Storage embankment and associated infrastructure footprint on vegetation area for the Storage

Vegetation Community	Storage embankment (ha)	Bobo Rd (ha)
Hardwood Plantation Forest	0.12	1.14
Wet Flooded Gum – Tallowwood Forest	0	0
Northern Wet Tallowwood – Blue Gum Forest	0	0
Foothills Grey Gum – Broad-leaved Mahogany Forest	0	3.02
Wet Bloodwood – Tallowwood Forest (Temperate Rainforest)	0	0
Pastureland	13.55	0.68
Riparian Vegetation	2.33	0.19
Total	16.00	5.03

Results

Prior to clearance it is estimated that there would be 133.25 tC/ha in the hardwood plantation and 199.61 tC/ha in native forest (including trees, debris and soil pools). Table 22-11 shows the biomass removed and equivalent emissions associated with the storage embankment and road construction.

Table 22-11 Biomass removed and equivalent emissions associated with storage embankment and road construction

Vegetation Community	Storage embankment (ha)	Storage embankment (t C)	Storage embankment (t CO_2)	Bobo Rd (ha)	Bobo Rd (t C)	Bobo Rd (t CO_2)	Total (t CO_2)
Hardwood Plantation Forest	0.12	16	59	1.14	152	557	616
Wet Flooded Gum – Tallowwood Forest	0	0	0	0	0	0	0
Northern Wet Tallowwood – Blue Gum Forest	0	0	0	0	0	0	0

Foothills Grey Gum – Broad-leaved Mahogany Forest	0	0	0	3.02	603	2,212	2,212
Wet Bloodwood – Tallowwood Forest (Temperate Rainforest)	0	0	0	0	0	0	0
Total	0.12	16	59	4.16	755	2,770	2,829

Clearing this vegetation down to bed rock would result in emissions of 2,829 t CO2-e.

IPCC method

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Appendix 2: Estimating CO_2 emissions from lands converted to permanently flooded lands) provide separate algorithms for CO_2 and CH_4 emissions from land converted to permanently flooded land. As the algorithm for CO_2 is designed explicitly to cover the ten years following flooding, the algorithms have been modified here, based on the conservative assumption that CH_4 is emitted across this period. Both algorithms have been designed such that they are applicable to regions where reservoir surfaces freeze during winter.

Vegetation

The equation used in the IPCC method does not require vegetation classification, however, it does require the climate to be specified. The climate where the land is situated was classified as a warm temperate and moist climate.

Assumptions

The following assumptions on emissions were made;

- There are no days in the year where reservoir surface are frozen;
- Warm temperate and moist climate is the best descriptor of the sites climate;
- The percentage of area flooded after 10 years is 100%; and
- Applies only to the area of inundation and not the storage embankment footprint.

Modelling Scenario

CO_2 emissions (t CO_2/10 years) $= 365 \times E(CO_2)_{diff} \times A_{flood,total_surface} \times f_A \times 10^{-6}$

CH_4 emissions (t CH_4/10 years) $= 365 \times E(CH_4)_{diff} \times A_{flood,total_surface} \times f_A \times 10^{-6}$

Where:

- $E(CO_2)_{diff}$ is measured diffusive CO_2 emissions (warm temperate moist climate, median = 8.1 kg CO_2/ha/day);

- $E(CH_4)_{diff}$ is measured diffusive CH_4 emissions (warm temperate moist climate, median = 0.150 kg CH_4/ha/day);
- $A_{flood,total_surface}$ is total reservoir surface area (ha);
- f_A is the fraction of the total reservoir area flooded after 10 years (conservative assumption is 100%); and
- 365 indicates the reservoir surface is not frozen for any days of the year.

Results

CO_2 emissions (t CO_2/10 years) = 17.3

CH_4 emissions (t CH_4/10 years) = 0.32

The emissions calculated using the IPCC methodology are significantly less than the estimated emissions using FullCAM. The IPCC results were not used in this GHG assessment.

Greenhouse Assessment Results Analysis

Greenhouse Gas Emissions Results

Emissions were calculated based on Scope 1, 2 and 3 emissions. The emission were categorised as either occurring during the construction period or operating period of the Proposal. While fugitive emissions due to decomposition of labile carbon pools is anticipated to occur for a period of time after inundation of the reservoir, these emissions have been categorised as occurring during construction for the purpose of this assessment.

Greenhouse Inventory

The greenhouse gas assessment indicated total construction emissions of 41,765 tonnes of CO_2-e over the construction period and average annual emissions of 745 tonnes of CO_2-e per annum. Scope 1, 2 and 3 emissions are summarised in Table 22-12. The total emissions inventory is given in Table 22-12.

Table 22-12 Summary of Scope 1, 2 and 3 emissions for Proposal

Scope	Quantity (t CO_2-e)
Construction emissions	
1	34,460
2	21
3	7,283
Total construction emissions	**41,765**
Operational emissions	
1	0
2	620
3	125
Total operational emissions	**745**

Emissions for construction were also categorised as construction materials (i.e. emissions associated with the extraction and processing of construction materials), transportation of raw materials to site, and construction activities. Construction activities are estimated to contribute 84% of all emissions associated with the Proposal, raw materials 9% and transportation 7%. The major sources of emissions during construction and operations are summarised in Section 22.3.2, and the total emissions inventory for construction is given in Table 22-5.

Major Emission Sources for Construction

The emission sources contributing to 90% of the total emission for construction are listed in Table 22-13.

Table 22-13 Emissions contributing 90% of total construction emissions for Proposal

Ranking	Source	Emissions (t CO_2-e)	Fraction of emissions
1	Vegetation removal in the inundation area	23,000	55%
2	Diesel consumption in construction equipment	9,300	22%
3	Vegetation removal for storage embankment and associated infrastructure	2,800	7%
4	Concrete	1,300	3%
5	Transportation of sand to site	900	2%
6	Transportation of diesel from the refinery to site	800	2%
Total		**38,100**	**91%**

Emissions Over the Life of the Proposal

The total emissions (construction emissions and annual operational emissions) for the first thirty years of operations are estimated to be 64,000 t CO_2-e. Projections past thirty years may provide inaccurate estimates due to likely changes in emission factors associated with electricity production. The construction emissions contribute approximately 65% of the total emissions for the first thirty years. This percentage would decrease as the operation of the Proposal extends past thirty years.

Annualising the construction emissions over a 30 year period would result in average annual emissions of approximately 2,100 t CO_2-e for the first 30 years of operations. This is approximately 0.001% of NSW's annual greenhouse gas emissions[2].

22.4 Mitigation Measures

22.4.1 Climate Change

The climate is changing and is predicted to continue changing. This is likely to have a range of impacts. The climate at the study area is currently described as subtropical with wet warm summers and dry, mild winters. A range of scenarios have been predicted on how this would

[2] Total annual NSW emissions (160 Mt CO_2-e) based on DCC 'State and Territory greenhouse Gas Inventories 2006'.

change in the future. The main impact these changes may have on the Proposal are considered to be related to water availability, water quality and infrastructure management.

Changes in rainfall patterns and temperature may impact on the water available for the Proposal and the volume of water lost from the storage area. Sea level rise, bushfire and rainfall intensity may impact on water quality. While changes in soil moisture, groundwater and higher temperatures/higher temperature extremes may reduce the structural integrity of infrastructure.

To mitigate the potential impacts of climate change, consideration has been given to the materials and design of the key components of the Proposal. Various management plans and strategies are also proposed.

To limit the impact that climate change has on water availability and quality, it is proposed that the following measures be incorporated into an EMP for the Proposal:

- Install several "sentinel" bores downstream of the existing borefield to monitor salinity and pick up change trends in relation to movement of the tidal wedge upstream.
- Provide a cost effective and efficient destratification system within the storage to avoid stratification;
- Monitor the Storage for algal blooms;
- Maintain the existing forest vegetation surrounding the Storage; and
- Prepare a Bushfire Management Plan for the Bowra Creek Catchment. Measures could include: placing hay bales along contours in the catchment to trap sediment in an attempt to reduce sediment loading in the storage following bushfire events.

To limit the impact that climate change has on infrastructure management, it is proposed that the following measures be incorporated into an EMP for the Proposal:

- Limit the length of the proposed underground piping; and
- Consider the predicted impacts during the design and material selection of the proposed pipelines.

22.4.2 Greenhouse Gas Consumption

Direct Construction Greenhouse Gas Minimisation

Vegetation removal

Emissions due to vegetation removal (both in the inundation area and for construction activities) contribute approximately 62% of the construction emissions and approximately 41% of the total emissions for the first thirty years of operations. The reduction in emissions due to vegetation removal can only be achieved through the avoidance of clearing. These emissions may be offset by the protection area through the change in ownership around the storage from DI&I to NSC.

Fuel consumption by construction equipment

Fuel (diesel) consumption by construction equipment is estimated to contribute 22% of the total construction emissions. The use of a biodiesel blend may reduce GHG emissions due to fuel consumption. The reduction in emissions is approximately equivalent to the percentage of biodiesel in the blend, when sustainable feedstocks of biodiesel are used. Calculations to

determine the reduction in GHG emissions when using biodiesel would consider the entire life cycle of the fuel.

Operational Greenhouse Gas Minimisation

Purchasing 100% GreenPower electricity

Indirect greenhouse gas emissions (i.e. those generated off site such as electricity use) can be minimised at the Proposal by purchase of renewable energy (GreenPower). As shown in Table 22-6, consumption of electricity is projected to be 700 MWh per year which is equivalent to 745 t CO_2-e. Purchasing 100% accredited renewable energy, such as GreenPower could remove these emissions from the inventory. GreenPower is, however, considerably more expensive than standard grid electricity.

GreenPower costs approximately an additional 5 cents per kWh (retail rate), which equates to an emissions reduction cost of $47/ t CO_2-e for NSW electricity. Switching to 100% GreenPower could cost an additional estimated $35,000 annually.

23 Cumulative Impacts

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that would be the focus of cumulative impact analysis. While impacts can be differentiated by direct, indirect, and cumulative, the concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time. Thus the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource no matter what entity is taking the actions.

23.1 Air Quality

Construction dust emissions have the potential to cause loss of amenity at nearby sensitive receptors. Storage construction work would occur within 200 metres of the nearest receptor. At this distance it is considered that adverse dust impacts would be significantly reduced and that the application of the recommended mitigation measures to reduce dust generation during construction would provide adequate protection to the amenity around these locations. GHD is not aware of any other significant developments in the vicinity of the Proposal that may exacerbate dust impacts during the construction phase.

Adverse impacts due to smoke emissions from vegetation burning may occur at nearby receivers. Recommendations for control measures and burning considerations are provided would burning be required. Emissions to air during the operation of the Proposal are expected to be negligible and would be adequately managed with consideration to the mitigation measures identified. Whilst any burning would contribute to the existing smoke emissions generated by the sawmill on the corner of Valla Road and Rodeo Drive, these emissions are unlikely to contribute to a significant adverse cumulative impact on air quality in the area.

23.2 Soil, Landform Stability and Erosion Hazard

The assessment of the impact of the Proposal on soils, landforms and waterway morphology indicates that most impacts would be largely mitigated through the implementation of appropriate erosion and sediment controls during the construction and operational phases. However, two key risk areas have been identified:

- The high risk of erosion of disturbed areas and the transport of sediment into Bowra Creek during the construction of the storage embankment and the clearing of vegetation in the inundation area; and
- The impact of the altered hydrological regime along Bowra Creek as a result of the construction and operation of the storage.

The former can be mitigated through the careful planning of construction staging, flow detention and diversion structures and erosion and sediment control measures and practices during the design phases of the Proposal. Stringent adherence to the erosion and sediment control plan and regular monitoring of erosion and sediment control measures and practices would be required during the construction phase.

To limit the potential for vegetation encroachment and sedimentation within pool environments of Bowra Creek, it is proposed that maximum capacity outflows of 3.7 m^3/s with durations of several hours be released from the storage twice yearly. These biannual releases would be in addition to regular transparent releases from the storage as close to the rainfall event as possible.

23.3 Terrestrial and Aquatic Flora and Fauna

The Proposal would require the clearing of approximately 80ha of native vegetation including 27.2 ha of hardwood plantation, 20.02ha of Wet Flooded Gum and Tallowwood Forest, 7.85ha of Northern Wet Tallowwood – Blue Gum Forest, 7.16ha of Foothills Grey Gum – Broad-leaved Mahogany Forest, 0.64ha of Wet Bloodwood – Tallowwood Forest (Temperate Rainforest), 14.23 ha of pastureland and 2.61 ha of riparian vegetation. Whilst there is no obligation under the *Native Vegetation Act 2003* to provide compensatory habitat for the loss of the vegetation as part of the Proposal, opportunities exist to provide some protection areas via the acquisition of land in and around the storage.

Three threatened flora species listed under the TSC or EPBC Acts were considered likely to occur in the study area including Minute Orchid, Leafless Tongue Orchid, Rusty Plum and Tylophora. The 7-part Tests concluded that no significant impact is likely on these species as a result of the proposed action. Therefore no Species Impact Statements are deemed necessary. No referral to the Commonwealth Minister in relation to the EPBC Act is necessary.

Numerous exotic plant species were observed during field surveys. Several noxious weeds were recorded in varying populations (Camphor Laurel, Lantana, Small-leaf Privet, Broad-leaf Privet, Weeping Wouldow, Giant Parramatta Grass, Crofton Weed and Mistflower). Feral dogs were recorded as well as hares.

Thirteen species of fauna listed under the TSC, FM and/ or EPBC Acts were confirmed as occurring within the study area. The fauna of conservation significance includes six mammal species (Koala, Spotted-tail Quoll, Grey-headed Flying-fox, Eastern Bentwing-bat, Golden-tipped Bat and Little Bentwing-bat), eight bird species (Masked Owl, Barking Owl, Sooty Owl, Powerful Owl, Glossy Black Cockatoo and Wompoo Fruit-dove) including two migratory birds (Rufous Fantail and Cattle Egret), and two frogs (Giant Barred Frog and Southern Barred Frog). The 7-part Tests concluded that no significant impact is likely on these species as a result of the Proposal. Therefore no Species Impact Statements are deemed necessary. No referral to the Commonwealth Minister in relation to the EPBC Act is necessary.

No aquatic fauna or EECs were recorded or assessed as likely to be occurring within the study area. Therefore no assessments of significance were undertaken for these components.

The key impacts associated with the Proposal including habitat loss, sedimentation and weed invasion. GHD is not aware of any other developments in the vicinity of the Proposal that may exacerbate ecological impacts in the area in the short term.

23.4 Surface Water/ Groundwater

The existing borefield extracts water from the alluvial soils adjacent to the Nambucca River and South Creek. There is a direct connection between the flow in the river and the level of water in the groundwater aquifer and therefore any extraction from the groundwater bores impacts on the flow of water in the river and creek. Currently there is no limit on the amount of extraction

which can occur other than an annual total limit of 3,100ML. The proposed expansion of the borefield would incorporate limits on extraction to protect the baseflow in the river system. The initial baseflow limit has been agreed to be set at the 95 percentile flow in the river. It is acknowledged however that there are uncertainties on the adequacy of this flow regime to protect the aquatic environment and safeguard against saltwater intrusion. As such an adaptive management framework would be implemented to monitor changes in river conditions.

The borefield pipeline crosses the Nambucca River at two locations and traverses a number of other smaller drainage lines. It is proposed that underboring be employed for the Nambucca River crossings whilst open trenching would be used for the smaller drainage lines. The transfer pipeline between the pumping station and the storage would cross Bowra Creek. It is envisaged that the pipeline be incorporated into the existing access crossing at Lot 2 DP 809380. The method by which this occurs would be confirmed during detailed design.

Construction of the storage would impede the transfer of flow and sediment along Bowra Creek. To ensure a balance, transparent flows and biannual discharges would be released to the tailwater receiving environment thereby replenishing surface water and underlying groundwater and reducing any impacts on the existing terrestrial and aquatic ecosystem.

Given the shallow nature of the alluvial aquifer, restrictions on the current and future land use in the area of the new bores would be required in order to minimise the cumulative effects associated with land use impacts on the water resource. GHD is not aware of any other developments in the vicinity of the Proposal that may exacerbate groundwater impacts in the area in the short term.

23.5 Water Quality

The water quality results obtained from sampling and testing of the borefield throughout its development and from the Nambucca River during periods of low and high river flow have indicated a broad range of water quality that can vary substantially depending on the season and the length of dry periods experienced prior to sampling.

Given good weather conditions and a reasonable river flow, the water quality available from the borefield is seen to be of an acceptable quality with a "low risk" associated with the need for further treatment.

The off-river storage is located in a forested catchment with little to no land disturbance. As such the quality of water in the storage would remain reasonably good. Due to the depth of the storage there is a risk of stratification and the Proposal would include a destratification system, a multi level off-take with at least two off-takes and regular seasonal environmental releases to address the potential for algal blooms and adverse impacts to downstream water quality.

It is proposed that a water quality monitoring program for implementation during filling and for ongoing operation of the storage.

The overall objective is to monitor, maintain and manage water quality generally in the storage during filling, storage and withdrawal operations. The storage is designed for supply of acceptable quality water when water quality/ quantity from the borefield falls below an acceptable level. Cumulative impacts in relation to water quality could include the inability to pump water from either the storage due to poor water quality or from the borefield during low flow periods in order to maintain environmental flows.

23.6 Noise and Vibration

Assuming construction activities would primarily be undertaken between 7 am and 6 pm Monday to Friday, and 7 am to 1 pm Saturdays, construction noise impacts may exceed the 41 dB(A) construction noise goal at nearby residential receivers based on the estimates made in this EIS.

Noise from the proposed pipeline construction has the greatest potential for impact due to the proximity of noise receivers to construction activity. However, given the mobile nature of construction activities, it is expected that noise receivers would only be exposed to elevated noise levels for relatively short periods.

With the general type of construction operations and the typical separation distance to nearby receivers, vibration impacts from general construction activity would be negligible. However, blasting, if it occurs is expected to generate the most significant vibrations levels and may cause vibration impacts at nearby receivers.

Estimations of airblast overpressure indicates that the recommended peak noise level of 115 dB(L) may be reached at up to 1500 metres from the blast location. Estimations of ground vibration levels indicates that the 5 mm/sec recommended limit may be reached at up to 300 metres from the blast location. As attenuation loss from screening of local terrain features has not been taken into account, these estimations are considered to be conservative.

Detailed assessments of noise impacts during the operations of the Proposal have shown that noise impacts are not expected to be significant. GHD is not aware of any other developments in the vicinity of the Proposal that may exacerbate noise impacts in the area in the short term.

23.7 Indigenous Heritage

One possible Aboriginal Object (NSW1) has been previously identified approximately 50 m from the proposed impoundment maximum storage level in the course of the 2004 survey of the storage area. Site NWS1 may be inundated when the storage is full. No Aboriginal sites were located in the course of the 2008 survey of ancillary areas.

One area of Potential Archaeological Deposit (NWPAD1) was identified in the course of the 2008 survey. The proposed transfer pipeline traverses the PAD area.

Several areas of cultural significance have been identified by the local Aboriginal community. Two of these areas a burial ground [the rocks] and corroboree and a mythological site. Neither would be impacted by the Proposal.

The Nambucca has over time been used for various cultural pursuits including swimming, fishing and as a food resource. As environmental flows in the river would be maintained as part of this project there would be no impact on this aspect of the study area.

Provided additional sub-surface investigations are undertaken prior to construction of the Proposal, there are not expected to be any cumulative impacts on indigenous heritage.

23.8 Non-Indigenous Heritage

Only two items were identified as part of the Cultural Heritage Assessment.

Based on its relatively poor condition, modified context, and lack of rarity, the forestry stump and felled trunk is assessed as having little heritage significance and is not considered to fulfil the criteria for local or State listing.

The reported charcoal pit NSWH2 has been substantially modified and survives as an archaeological site only, with low ground relief providing the only above ground evidence. Apart from small traces of brick, there are no traces of the reported additional brick kiln. As a consequence, this site is assessed as having little heritage value and is not considered to fulfil the criteria for local or State listing. It would not be affected by the Proposal.

Provided the reported charcoal pit is avoided during construction of the Proposal, there are not expected to be any cumulative impacts on non-indigenous heritage.

23.9 Traffic

If all construction access is to be via Valla Road then the estimated current AADT at Bobo Road intersection may increase from say 200 to 390. Whilst this is a relatively significant impact over the current base, as the base traffic is extremely low the potential adverse impact on other motorists or surrounding properties is also quite small.

In regard to the potential impact upon Rodeo Drive, assuming that all traffic travels east of Valla Road then the AADT (2011) may increase from 1,700 to 1,890. This is an increase of 11%. By comparison, if the natural traffic growth in the area is 3% then natural growth would produce a similar increase without the construction traffic in 3 years.

It is clear then, that the construction period impacts for Rodeo Drive are relatively low in comparison with existing traffic levels and equate to relatively short periods of natural traffic growth. The construction impact for Bellingen Road and North Arm Road is more pronounced as the existing traffic levels are much lower.

It is expected that the storage would not be available for recreational usage in order to protect water quality. A viewing area would be provided for public access, but visitor numbers would be expected to be very low and the scenic value is not expected to be high.

In terms of daily traffic movements associated with the range of activities listed above, there may be limited movements per day and the frequency of days may be irregular. Therefore, operational impacts are difficult to quantify but relatively insignificant.

Provided appropriate traffic management is implemented during the construction phase of the Proposal, there are not expected to be any cumulative impacts in relation to traffic.

23.10 Visual Amenity

The potential impact of the Proposal on the landscape character and visual amenity within Bowraville has been considered for the construction and operation phases.

Overall, the visual catchment portrays clear evidence of human occupation with large areas of the landscape cleared of native vegetation, particularly in the lower lying parts of the valley, whilst the steeper mountain slopes of the catchment appear natural and heavily vegetated with tall (over 20 metres) trees.

The Proposal would be visible from scenic ridgelines and slopes, however there are a low number of receptors on these elevated areas, the distance is significant and the views are

largely screened by topography and local vegetation. There is only one receptor in close proximity to the Proposal in particular the storage embankment.

Overall, the significance of the changes to the landscape and visual amenity of the surrounding catchment for the receptors is considered moderate to low.

GHD is not aware of any other developments in the vicinity of the Proposal that may exacerbate visual impacts in the area in the short term.

23.11 Waste Management

Waste materials generated during construction and operation of the Proposal would be managed in accordance with the principles and the waste management hierarchy. Prior to commencing construction works a detailed Waste Management Plan would be prepared. The Waste Management Plan would incorporate the principles of the waste management hierarchy and the identified mitigation measures.

Based on the current understanding of the waste to be generated during the construction and operation of the Proposal, there are not expected to be any cumulative impacts in relation to waste.

23.12 Hazards and Risks

The environmental hazards and risks associated with the Proposal relating to flooding, bushfire, contaminated land, dust, noise, pests, weeds, blue green algae and chemical use have all considered the potential for cumulative impacts. GHD is not aware of any other developments in the vicinity of the Proposal that may exacerbate the identified environmental hazards and risks in the area in the short term.

23.13 Social Economic

The Proposal may have flow on effects on the management of community facilities, such as local schools and health services, through an increase in population during construction. However these impacts would be short term and would be taken into account by local service providers, community organisations and local businesses.

23.14 Utilities and Infrastructure

There are unlikely to be any cumulative impacts in relation to utilities and infrastructure provided the identified mitigation measures are implemented.

23.15 Land Use

It is considered that the location of the borefield collection system, transfer pipeline, and access tracks would have minimal impact on existing land use apart from temporary impacts during construction. The location of the pipeline would lie adjacent to the Nambucca River and South Creek, where possible.

The easement is not expected to result in the severance of any affected properties and would result in a negligible loss of productive agricultural land and therefore there is not expected to be any detrimental affect on the ongoing viability of existing farms.

Designated locations, yet to be determined, would be required for construction compounds/ temporary holding yards for construction equipment and material. It is anticipated that at least 5 compounds with areas of approximately 600m^2 would be required throughout the construction phase. These compounds would be located on cleared and relatively flat land adjacent to the northern and southern banks of the Nambucca River, eastern and western banks of Bowra Creek and western bank of South Creek in the vicinity of the proposed borefield and transfer pipeline. In addition, the augmentation of the electricity network would be required by Country Energy to extend power lines to the proposed power transformers on the north and south banks of the Nambucca River and to the south of North Arm Road adjacent to South Creek. Separate approvals would be required for these works.

GHD is not aware of any other developments in the vicinity of the Proposal that may exacerbate land use impacts in the area in the short term.

23.16 Climate Change and Greenhouse Gas Emissions

Given the nature of climate change and the impacts of greenhouse gas emissions, the predictions made in Chapter 22 are considered to cover the cumulative impacts of the Proposal.

Part E Environmental Management and Monitoring

24 Environmental Management and Monitoring

24.1 Licences and Approvals

The licences and approvals required for the Proposal are outlined in Table 24-1 below.

Table 24-1 Licences and Approvals

Act	Approval / requirements	Authority
Environmental Planning and Assessment Act 1979	◗ Part 5 'Activity' Approval.	NSC and others
Heritage Act 1977	◗ Notification of intention to impact the forestry stump, site NWSH1, in writing to the Director of the NSW Heritage Office.	NSW Heritage NSC
National Parks and Wildlife Act 1974	◗ Section 87 permit to carry out sub-surface investigations within the identified PAD. ◗ Should any items of significance be identified as part of the sub-surface investigations, a Section 90 consent to destroy would be required.	NSW Department of Environment, Climate Change and Water (formerly DECC)
Protection of the Environment Operations Act 1997	◗ Environment Protection Licence for the excavation of material from on-site borrow areas. ◗ Environment Protection Licence for water releases from the storage that may pollute the environment.	NSW Department of Environment, Climate Change and Water (formerly DECC)
Water Act 1912	◗ Licence to construct bores under Section 112. ◗ Section 167 flood control work approval.	NSW Department of Environment, Climate Change and Water (formerly DWE)
Water Management Act 2000	◗ A controlled activity approval would be required for the Proposal for water access.	NSW Department of Environment, Climate Change and Water (formerly DWE)
Fisheries Management Act 1994	◗ Section 200 approval for dredging and reclamation ◗ Section 218(5) notification to Minister ◗ Section 219 permit in relation to the construction of fish passage at existing pipeline crossing of Nambucca River.	NSW Department of Industry and Investment (formerly DPI)

Forestry Act 1916	◗ The acquisition approval process required under the *Forestry Act* but would not take place until it is known whether the Proposal has been approved and NSC begins land acquisition prior to commencement of construction.	NSW Department of Industry and Investment (formerly DPI)
Local Government Act 1993	◗ Approval under s60 of the Local Government Act 1993 to construct the off-river storage.	NSW Department of Environment, Climate Change and Water (formerly DWE)

24.2 Draft Construction Environmental Management Plan

There are a number of activities taking place during the construction phase of the Proposal which have the potential to impact on environmental values in the area. These are:

- vegetation clearing within the full supply level;
- construction of earthen embankments, storage embankment and spillway;
- construction and installation of bores, borefield pipeline collection system and transfer rising main;
- construction of headworks and installations of pumps;
- construction of a fishway at the existing pipeline crossing across the Nambucca River;
- installation of intake tower;
- operation of workshop (fixed and mobile);
- construction of recreation areas;
- operation of site / administration office;
- use of vehicles and equipment on site;
- operation of quarry, borrow pit and screening areas;
- construction and use of haulage roads; and
- upgrade of roads, telecommunication, power transmission and associated infrastructure.

The environmental elements to be addressed in the Draft CEMP are as follows:

- Air Quality;
- Soils;
- Terrestrial and Aquatic Ecology;
- Noise and Vibration;
- Waste;
- Hazard and Risk;
- Traffic and Transport;
- Visual Amenity;

- Social & Economic Environment;
- Utilities and Infrastructure; and
- Land Use.

The specific mitigation measures for each of the above elements is discussed in Section 24.3.

24.3 Mitigation Measures

24.3.1 Air Quality Mitigation Measures

The following general measures are to be incorporated into the CEMP for the Proposal:

Dust Emissions from Construction

- Bobo Road, as the primary access road to the main storage area, be sealed prior to the construction phase to minimise dust generation from haul trucks.
- Water trucks be used on Valla Road during heavy use to minimise dust generation from haul trucks.
- Pre-water construction areas and stockpiles before they are disturbed and continue watering during any activities where fugitive dust may be produced;
- Where practicable, storage piles would be located in areas away from traffic areas, protected from the wind and away from public vantage points;
- Soil surfaces exposed for long periods of time would be covered with mulches or covers to stabilise soil;
- Limit cleared areas of land and clear only when necessary;
- With the exception of the inundation area, retain existing vegetation where possible and re-vegetate cleared areas and stockpiles with fast growing species for rapid coverage to temporarily or permanently stabilise soil;
- Control on-site traffic by designating specific routes for haulage and access;
- All trucks hauling dirt, sand, soil or other loose materials along public roads would be covered;
- Material spillage on roads and pathways would be cleaned up at regular intervals;
- Wheel washers would be installed where vehicles enter and exit unpaved roads onto paved roads, or wash off trucks and any equipment leaving the site each trip to remove dirt, mud or debris from tyres; and
- Establish real-time dust (PM_{10}) monitoring at receptor to the southwest of the storage site.

Smoke Emissions from Burning

Considerations for smoke control measures have been sourced from the DECCW's Air quality guidance note *Agricultural Stubble Burning* and from the DECCW Regulation of open burning in NSW, *An environmental guideline for NSCs, fire management authorities and landowners.*

Control technologies and methods for managing smoke emissions from vegetation burning are provided below:

- High temperature pit burning would be used over at-ground or stockpiled fires;
- Burning vegetation would be extinguished to stop or control impacts due to emissions;
- The use of fuels or fire accelerants is not proposed;
- The area to be lit and supervision is one way of managing or controlling the potential extent of impacts, by limiting the volumes of smoke produced and the dimensions of the ensuing smoke plume;
- Burning would only occur when prevailing wind direction is blowing away from town and nearby residents. Burning would not be conducted when prevailing winds are in the direction of nearby residences or when meteorological conditions do not allow proper dispersal of smoke;
- Burning would not be scheduled after rain;
- A communication strategy for keeping the community informed about when vegetation burning is scheduled would be implemented;
- Prior to any burning, the NSW Rural Fire Service would be consulted; and
- All burning operations would be supervised.

24.3.2 Soil, Landform Stability and Erosion Hazard Mitigation Measures

The following general measures are to be incorporated into the CEMP for the Proposal:

Sediment and Erosion Control Plan

A site Sediment and Erosion Control Plan would be prepared (and incorporated into a Construction Environmental Management Plan). The Sediment and Erosion Control Plan would be developed in accordance with the requirements of the 'Blue Book' (Managing Stormwater: Urban Soils and Construction, NSW Department of Housing).

The Sediment and Erosion Control Plan would have the following structure:

- Site characteristics – including existing contours, limitations of the site's soil type and climatic data including rainfall;
- Clearing and disturbance of the site – nature and extent of proposed ground disturbance, final contours and location of any temporary soil stockpiles and visual screening mounds;
- Existing and proposed drainage patterns – including existing surface water drainage paths and proposed drainage design;
- Erosion control practices – including the location and design of erosion control measures and the monitoring and maintenance of these control structures. Erosion protection measures would be implemented to minimise the potential for erosion of soils from the proposed development. Provided these measures are adequately implemented and maintained it is unlikely that any significant erosion would occur following excavation of soils and disturbance of ground areas. Controls would be implemented before any construction commences and inspected regularly particularly after a rainfall event;
- Sediment control practices - including the location and design of sediment control measures and the monitoring and maintenance of these control structures. Controls would be

implemented before any construction commences and inspected regularly particularly after a rainfall event; and

- Rehabilitation program – including the revegetation of landscaped areas and visual mounds.

Erosion and Sediment Control Practices

Sediment and erosion control practices and measures would include:

- The location of site compounds would consist of existing cleared areas and, where possible, on the right of way in order to minimise disturbance;
- All cut and fill batters would be protected from run-off and stabilised immediately following construction;
- Permanent drainage structures would be installed with sediment traps at completion of initial earthworks;
- Where possible 'clean' surface water would be directed away from disturbed areas to stable or stabilised discharge points;
- Upstream diversion drains and downstream sediment traps would be used to carry run-off away from disturbed areas;
- Where creation of sediment laden runoff cannot be prevented or where extracted groundwater cannot be discharged to existing surface waters, temporary sediment control ponds would be constructed to intercept sediment laden run-off and to trap and retain sediment; and
- Sediment traps would be placed in drainage lines to prevent sediment transport via surface water flows.

Soils and Spoil Management

The following management measures are made in regard to the management of soils and spoil during construction:

- Construction excavation activities would be limited to the original construction design to minimise the influence to geology and soils.
- The extent of exposed and unprotected areas would be limited by preserving existing groundcover;
- Construction practices would aim to eliminate the generation of excess topsoil (i.e. all topsoil would be used to rehabilitate the near surface ground following backfilling of the pipeline trench);
- Topsoil would be held in storage (preferably piled to one side of the trench) for the minimum possible time before being re-used directly on-site, preferably being replaced in its original location;
- Top soil would be seeded for the duration of storage, and silt barriers used whilst seeding is establishing;
- Where possible, topsoil would be recovered through the reuse of materials for remediation purposes. This would involve being spread evenly over the backfill material to reflect the final backfill contours;

- General spoil would be removed from the site and adequately covered during transportation to avoid wastage;
- Spoil would be stored stock-piled material with the appropriate covering and, if required, additional wind protection;
- Topsoil and spoil would be stockpiled separately to eliminate contamination through mixing;
- Stockpiles would not be placed in high water flow areas and would be protected by sediment control barriers or diversion drains;
- Where possible, spoil would be recovered through the reuse of materials for remediation purposes. Reinstatement would occur prior to hydrostatic testing of the installed pipeline, where practical;
- Following backfilling of the pipeline trench all disturbed areas would be seeded to promote stabilisation through revegetation, as soon as possible.
- Excess spoil materials would be utilised at other locations along the pipeline for remediation purposes, or utilised by landowners or NSC; and
- Disposal of spoil material, where inappropriate for reuse as an example, would be undertaken as a last resort.

Stabilised Access Point and Site Traffic

The following management measures are made in regard to the management of soils for site traffic and at site access points:

- The number of access points would be limited to one entry/exit point where possible;
- All access roads would be controlled on the site and vehicles and plant would be kept to well defined haul roads to minimise ground disturbance and compaction;
- Where there is more significant and heavier traffic, the use of a grid or vehicle wash bay would be considered to remove excess soil and dust before leaving the site. The grid or vehicle wash bay would be lifted and cleared out periodically; and
- Oil or fuel leakages from vehicles and equipment through regular maintenance would be minimised. Refuelling of vehicles would only occur in designated areas where spill containment and control equipment is stored.

Storage Construction and Clearing of Inundation Area

Given the high risk of soil erosion and the subsequent transport of sediment into Bowra Creek associated with the construction of the storage embankment and clearing of the inundation area, the following additional measures are provided to reduce this impact:

- Clearing of riparian vegetation within the inundation area would not take place until the coffer dams are complete to reduce the risk of transport of sediments into the downstream environment of Bowra Creek;
- Prior to construction, establish and stabilise temporary surface drainage, erosion protection and ongoing water quality management across the site through measures such as:
  - creek flow diversion structures, outfall protection and upstream and downstream detention ponds

- temporary runoff barriers
- sedimentation ponds
- progressive rehabilitation as work stages are completed.

- Make provision for safety and site stability in the event the upstream detention basin is over-topped and the site is flooded;
- Regularly monitor turbidity levels within detention ponds;
- Ensure releases from the detention basins do not exceed set limits; and
- Ensure permanent surface drainage system avoids drainage concentration over disturbed areas. In the event this is not feasible, adequate permanent erosion protection and flow detention in the form of sedimentation ponds would be required.

Monitoring

As part of the Erosion and Sediment Control Plan, monitoring measures would be implemented and include:

- Regular monitoring on the effectiveness of sedimentation and erosion controls measures after significant rainfall;
- Regular monitoring on the effectiveness of erosion controls during construction would include inspection of sediment traps to ensure sediments are not transported off site;
- Regular water sampling of sedimentation ponds;
- Ensuring suspended sediments in released waters do not exceed set limits; and
- Monitoring of turbidity downstream of construction sites.

24.3.3 Nambucca River Mitigation Measures

The following sections outline mitigation measures to limit the identified impacts on soils, landforms and waterways from the construction and operation of the additional borefields, power supply infrastructure and the borefields collection pipeline.

Design and Construction Impact Mitigation

The following measures are made to mitigate identified impacts on soils and landforms along the Nambucca River and South Creek in respect to the design and construction of the Proposal:

- Avoid heavy vehicle movements across the floodplains soils following rainfall events;
- Vehicle access routes across the floodplain soils would avoid lower lying areas where water may pond for extended periods;
- Avoid or minimise disturbance of flood channel areas. Where soils within floodplain channels require disturbance, ensure the duration of construction activities are minimised as far as practical and rehabilitate the disturbed area as soon as possible after construction activities have ceased in the area;
- Limit the duration that trenches that run parallel to river flow are open;

- Soil material generated from bore placement, trenching and waterway crossing excavations would be transported to a storage area outside of the effects of flooding along the Nambucca River and South Creek;
- Avoid any disturbance or removal of riparian vegetation along the Nambucca River and South Creek;
- Avoid disturbance to the banks and bed of the Nambucca River and South Creek; and
- Implement appropriate erosion and sediment control practices and measures during construction as outlined in Section 8.

Operational Impact Mitigation

The following measures are made to mitigate identified impacts on soils and landforms along the Nambucca River and South Creek in respect to the operation of the Proposal:

- Implement identified stabilisation works in conjunction with DI&I, NRCAM and Nambucca Valley Landcare (see Appendix B);
- Maintain the existing pipeline crossing across the Nambucca River and retrofit to provide fish passage;
- Monitor fish passage and stabilisation works through visual inspections following flood events equivalent to the 1 in 1 year ARI or greater.

24.3.4 Bowra Creek Mitigation Measures

The following measures are made to mitigate the identified operational impacts of the storage on the downstream geomorphology of Bowra Creek:

- To avoid scour immediately downstream of the proposed outlet, placement of a flow dissipation structure and channel protection works may be required;
- To limit the potential for vegetation encroachment and sedimentation within pool environments of Bowra Creek, it is proposed that maximum capacity outflows with durations of several hours be released from the storage twice yearly during the flood season. The success or otherwise of this measure is difficult to predict as the potential channel adjustments are dependant on a range of variables that cannot be readily quantified. Hence, it is proposed that an adaptive management framework be implemented to inform the management of flow releases based on a monitoring program that includes:
  - Monitoring of pool depths;
  - Monitoring of the bed and bank stability of the waterway; and
  - Monitoring of changes in the distribution of vegetation colonisation within the channel.

24.3.5 Contaminated Land

- It is proposed that further sampling be undertaken to confirm the Hydroilex results at Monitoring Bore 7 to confirm the results obtained from Hydroilex.
- Excavated soil proposed to be moved from one place to another would be verified to confirm it is not contaminated.

- The Environmental Management Plan (EMP) for the Proposal would need to detail appropriate procedures for the handling, stockpiling and assessment of potentially contaminated fill and materials during the construction phase.

24.3.6 Terrestrial and Aquatic Flora and Fauna Mitigation Measures

The following mitigation measures would be implemented:

- Mitigation measures to be undertaken prior to commencement of Proposal (e.g. pre-clearance surveys);
- Mitigation measures to be undertaken during the Proposal (e.g. clearly marking areas to be cleared); and
- Mitigation measures to be undertaken after the Proposal has been completed (e.g. the provision of a protection area and environmental monitoring of the study area).

These measures wouldbe implemented to ensure that any unforeseen potential impacts that may occur upon any threatened biota that are known to occur or may potentially occur, or their habitats that are known to occur or could potentially occur within the study area. These measures would also ensure that the impacts upon other native flora and fauna and the general environment of the study area would also be minimised.

24.3.7 Mitigation Measures prior to commencement of Proposal

Preparation of Environmental Management Plans

A CEMP would be prepared for the Proposal and would include:

- An Erosion and Sediment and Control Plan (ESCP) would be developed and implemented before, during and after the works to protect soils and prevent erosion after rainfall events and wind erosion, particularly for works along the steeper slopes and where moderately dispersive soils are identified. Sediment and erosion control structures, which conform with the relevant guidelines, would be installed in stages as vegetation is cleared and appropriately installed where major infrastructure is to be located e.g. dam embankment and access roads;
- A Weed Management Plan (WMP) would be developed in the design stage of the storage and initiated prior to works commencing for implementation before, during and after the works are completed to prevent the spread of introduced species and declared noxious plants recorded within the study area. The WMP would encompass the areas where infrastructure is to be upgraded or developed along the pipeline route, borefield locations, access road upgrades and the dam embankment. Due to under riverbed boring for the pipeline being undertaken, it is not envisaged that riparian vegetation along Nambucca River or South Creek would be adversely impacted. Therefore revegetation and rehabilitation works for these areas is not necessary;
- A Flora and Fauna Management Plan (FFMP) comprising of sub-plans to provide protocols/management strategies to minimise adverse impacts on retained native vegetation and habitat and resident fauna (e.g. pre-clearing and clearing surveys), these are described in more detail below:

24.3.8 Protocols to Protect Vegetation prior to Clearing

- Areas of native vegetation that needs to be cleared would be clearly marked on maps and identified with parawebbing or flagging tape in the field to ensure that clearing does not occur beyond the area necessary for the Proposal; and
- Locating the construction compounds and materials stockpiles in areas that are currently cleared or disturbed wherever possible. This would reduce the need to clear additional areas of natural vegetation.

24.3.9 Protocols to Protect Fauna prior to Clearing

Pre-clearance Survey

It is recommended that a pre-clearance survey be conducted prior to the commencement of any of the proposed activities to identify and flag Koala habitat trees, hollow bearing trees, stags, rocky outcrops, large hollow logs and hanging bird nests, preferably by a qualified ecologist.

A two staged approach would be used to undertake for the pre-clearance surveys as specified below.

Stage 1 – prior to commencement of clearing

Inspection of clearing areas to identify and mark habitat features (large trees with obvious hollows, rocky outcrops, large logs, hanging bird nests etc.) that would need special attention during clearing and to identify features suitable for placement into the protection area to maintain habitat resources (e.g. large rocks and logs).

Stage 2 – surveys during clearing

- Inspection for Koalas and follow protocols relating to Koalas if one is found;
- Banging of habitat trees, careful felling and inspection of hollows once felled (protocols for this are described below);
- Inspection of hanging bird nests for Golden-tipped bats;
- Adhere to protocols for removing fauna e.g. bats, temporarily holding and releasing at dusk to be developed in consultation with DECCW and detailed in fauna management sub-plan of CEMP;
- Inspection of other habitat features ahead of clearing e.g. rocky outcrops and large hollow logs for Spotted-tail Quolls or other denning fauna; and
- Make sure that any fauna that is disturbed are encouraged to move into areas of retained habitat, dealing with injured animals if required in accordance with injured animal protocols.

Habitat inspection and relocation

Habitat inspection of the clearance zone to identify any logs, rocks or other fauna habitats considered suitable for relocation into nearby habitat areas. Habitat suitable for relocation marked with paint to be relocated to protection area. Any felled trees and limbs that were considered suitable for habitat relocation including limbs with hollows, cracks and fissures and shedding bark. Other limbs without these attributes currently may also be used for habitat relocation, as fissures would form in time as these felled limbs decay.

24.3.10 Protocols to Protect Fauna during clearing

A suitably qualified ecologist must be on site during the removal of Koala habitat trees, hollow bearing trees, stags, rocky outcrops, large hollow logs, hanging bird nests and other significant habitat components (as identified in the pre-clearance surveys), to ensure all items are checked. Any injured fauna as a result of the clearing activities must be attended to by a member of WIRES or by a local veterinarian. Protocols relating to certain species are outlined in the following sections.

Vegetation Clearing Protocols

The vegetation clearing protocols would include:

- Hollow logs, leaf litter and woody debris and large boulders that provide refuge for native fauna identified during the pre-clearing surveys would be removed during construction would be redistributed into the protection area. This would minimise the removal of dead wood from the locality, which has been listed on the TSC Act as a key threatening process;
- Each stage of vegetation clearing undertaken by DI&I and then the contractor to NSC would commence from the storage embankment and work upslope through the inundation area;
- Trees would be felled away from retained vegetation where possible to reduce the incidence of unnecessary impacts to adjacent vegetation;
- Fallen timber in the form of hollow bearing trees or stags would be gently lowered during felling and carefully placed into the edge of adjacent forest that is to be retained, whilst avoiding access by heavy machinery into this 'no go' area (i.e. area beyond the cleared storage perimeter). This practice would ensure that additional habitat is provided or maintained for any threatened fauna potentially relocating. This would be completed under supervision by an ecologist or appropriately qualified person;
- Ensure an experienced ecologist or wildlife handler is present to manage and retrieve any displaced wildlife during clearing activities. The handling protocols are detailed below for uninjured and injured fauna;
- Relocating displaced fauna to similar habitat at the closest available secure location; and
- Exposed surface soil would be stabilised as soon as possible to avoid potential erosion (by mulching, covering or replanting with native grass species where appropriate).

Fauna monitoring during clearing

Vegetation or other habitat features identified as potentially harbouring fauna would be monitored by an ecologist during clearing activities.

Removal of Hollow-bearing Habitat Trees and Large Hollow Logs

Particular attention would be given to those trees with substantial hollows or large hollow logs identified during the initial pre-clearing site investigation as potential habitat for native fauna. Adjacent non-habitat trees and other surrounding vegetation would be removed 24 hrs prior to habitat tree removal providing fauna with an opportunity to exit the tree to minimise the potential for unnecessary mortality or injury during tree felling activities and stress associated with handling.

The following steps would be taken before clearing of vegetation surrounding identified habitat trees and logs:

- Surrounding vegetation would be inspected by an ecologist for the presence of native fauna, including searches for Koalas;
- Where a Koala is detected a temporary vegetation clearing exclusion zone of a minimum of 30 m radius must be established around it, until the Koala vacates the tree;
- Where other fauna are encountered they would be captured and released into adjoining secure habitat or gently encouraged to leave the construction area and directed into adjoining habitat; and
- Where no fauna species are detected clearing of vegetation surrounding habitat trees and logs can proceed. The clearing activities would be monitored by an ecologist to detect any fauna observed to be at risk.

The following protocols would be implemented for the removal of identified hollow-bearing trees and hollow logs:

- Hollow-bearing trees or trees thought to harbour fauna would be felled, and large hollow logs removed, under the supervision of two wildlife specialists. These specialists would have appropriate permits and animal-handling equipment. The local veterinarian would also be contacted and informed of the impending clearing activities;
- Prior to felling or removal, clearing machinery would be used to gently shake or 'bang' the habitat tree or log for a period of 2-3 minutes (dependant on tree health and structural integrity) to encourage any resident fauna to vacate hollows. Sticks, poles or other similar hand-held objects would also be used to hit the trunk of the tree or log at various points, to encourage animals to vacate the tree/log. The tree or log would be observed for at least 5 minutes prior to completing the next action; and
- After the observation period, each tree would be felled at the base. Once it has been deemed safe to inspect each tree by the excavator operator, hollows in felled trees would be inspected for fauna that may be present (uninjured, injured or deceased).

Inspection of Rocky Outcrops

Rocky outcrops identified during the pre-clearing surveys would be inspected prior to clearing by a wildlife specialist for the presence of sheltering fauna. Any fauna detected would be captured and released in adjoining areas of suitable habitat or encouraged to vacate the construction area and directed into adjoining habitats.

Uninjured captured individuals

Uninjured captured individuals would either be:

- Released immediately into adjoining retained habitat outside of the Construction Area, particularly for diurnal species (e.g. <150 m away); or
- Temporarily retained in captivity until dusk, then released at the nearest suitable location away from the area being cleared (e.g. <150 m away), particularly for nocturnal species.

Injured individuals

If injured animals are found, then the local veterinarian or WIRES representative would contacted.

Stockpiling of hollow logs and branches and rocks

Hollow-bearing branches, logs, tree trunks and large rocks identified during the pre-clearing surveys would be stockpiled for placement in the protection area.

24.3.11 Mitigation Measures during construction of the Proposal

- Any infrastructure and machinery required for the proposed activities would be positioned to avoid retained native vegetation (e.g. adjacent vegetation outside designated clearing areas);
- *Noxious and environmental weeds would be controlled through a WMP included in the CEMP;
- Drainage and runoff would be controlled in such a way as that no foreign substrates or materials leave the site;
- Exposed surface soil would be stabilised as soon as possible to avoid potential erosion (by mulching, covering or replanting with native species);
- Excessive dust would be suppressed via watering dust generating soil or stock piles; and
- *The avoidance of soil disturbance in or near remnants, such as ripping planting lines and road grading.

* - Mitigation measures to be also undertaken after the proposed works are complete.

Timing of Clearing

The colder months of the year represent a time when fauna may be in torpor, less active and less willing to relocate.

In general, for all species, and particularly hollow dependent species, they are generally less likely to survive if you move them in winter because some are in torpor and for others it may be more difficult to find foraging resources and new territory or roosting habitat.

Key times to avoid where possible would be breeding times for Owls, however the only large hollow bearing trees or stags are located along Bobo Road and protocols have been provided to reduce the possibility of any potential impacts upon these trees that would be marked during the pre-clearance survey.

The Bentwing-bats breed in caves or similar areas so clearing is unlikely to significantly impact their breeding colonies. Additionally protocols have been provided to reduce the possibility of any potential impacts upon any Bentwing-bats that may be roosting in stags or hollow bearing trees that would be marked during the pre-clearance survey.

The mitigation measures and protocols prescribed above would reduce the potential impact upon any of the threatened fauna species that have been recorded or are considered likely to occur, as well as any non-threatened fauna species that may be present when clearing takes place.

Table 9-13 depicts the seasonal flowering or breeding periods of the threatened flora and fauna species recorded or considered likely to occur in the study area.

Table 24-2 Flowering or Breeding Periods of Threatened Species Occurring or likely to Occur in the Study Area.

Species	Seasonal Flowering or Breeding Periods											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barking Owl												
Masked Owl												
Sooty Owl												
Powerful Owl												
Glossy Black Cockatoo												
Wompoo Fruit-dove												
Koala												
Golden-tipped Bat												
Little Bentwing-bat												
Eastern Bentwing-bat												
Spotted-tail Quoll												
Grey-headed Flying-fox												
Southern Barred Frog												
Giant Barred Frog												
Rusty Plum												
Tylophora												
Minute Orchid												
Leafless Tongue Orchid	*	*	*	*	*	*	*	*	*	*	*	*

* Indicates unknown flowering period of species

Green indicates the flowering/ breeding periods for the threatened flora and fauna species occurring or likely to occur in the study area.

24.3.12 Mitigation Measures Post Proposal Construction

The amelioration measures to be undertaken after the proposed development include:

- Exposed surface soil would be stabilised progressively as soon as possible to avoid potential erosion (by mulching, covering or replanting with native grass species); and

- The transparently operated storage as specified in the Water Quality Report component of the EIS would be implemented through a spillway system and controlled release of water to ensure ecological processes are sustained and that adequate flows to maintain habitat for aquatic biota is provided along Bowra Creek;
- Initial detailed monitoring assessments of the transparently operated storage would be conducted for the downstream sections of Bowra Creek below the inundation area. These assessments would serve as a benchmark for determining the long-term effectiveness of the transparent release of water from the off-river storage to sustain the environmental flow below the inundation area;
- Monitor aquatic weeds, particularly Parrots Feather *Myriophyllum aquaticum*, and develop a removal management plan to ensure the ongoing control of aquatic weed species that may be introduced by waterbirds or humans; and
- Monitor for Gambusia and develop a removal management plan if the species if identified.

24.3.13 Provision of Protection Area

There is the potential for direct and indirect impacts on biodiversity values as a consequence of the proposed development. While many of these impacts can be adequately mitigated or managed, there are impacts associated with certain aspects of the proposed development where measures to avoid and mitigate are not possible. These impacts are called residual impacts. The primary residual impact associated with the proposed development would be the loss of native vegetation in the inundation area, including known and potential habitat for threatened flora and fauna species listed under the TSC and EPBC Acts.

To address the residual impacts of the Proposal, NSC have nominated a potential protection area that would be conserved in perpetuity and contribute to the long term conservation of biodiversity in the locality. The proposed protection area has been devised in cooperation with the existing landowner (DI&I) and comprises approximately 123 ha of native vegetation above and surrounding the proposed inundation area where current logging activities would cease after acquisition. It contains vegetation communities representative of those that are to be removed from the inundation area and provides for an offset ratio of approximately 1.88 : 1 as detailed in Table 9-14.

The protection area is designed to account for any potential direct, indirect or residual impacts upon threatened species that may be associated with the Proposal that may not be adequately controlled through the proposed mitigation measures. The proposed protection area aims to offset the vegetation to be removed, as a whole, and is not able to offset each vegetation community at the same ratio that the whole protection area does. To achieve such outcome, corresponding vegetation communities of the right size to accommodate the same ratio would need to be identified further a field and purchased by NSC. This could be considered impractical, expensive and difficult to manage.

The protection area has not been designed to offset each vegetation community to be removed at the same ratio as is to be retained (i.e. 1:1). The emphasis is on the long-term protection of habitat for threatened and non-threatened species and the removal of the vegetation clearing KTP, associated with logging practices, from the vegetation to be retained. This is not

considered to be significant regards to the vegetation communities identified being only able to support certain threatened or non-threatened species.

The structurally modified state of each vegetation community to be cleared is unlikely to be considered species specific habitat. The species recorded or considered likely to occur or may possibly occur in the vegetation to be cleared are considered likely to breed, forage and/or roost in all of the vegetation communities identified. This then applies to the vegetation communities associated with the proposed protection area.

Table 24-3 Protection Area including retained native vegetation

Native vegetation communities to be cleared in the inundation area	Native vegetation communities to be retained in land acquired from DI&I	Total area (ha) to be retained as protection area	Total area (ha) to be cleared
• Foothills Grey Gum – Broad Leaved Mahogany; • Northern Wet Tallowwood – Blue Gum; • Wet Bloodwood – Tallowwood (Temperate Rainforest); • Wet Flooded Gum – Tallowwood; and • Hardwood Plantation.	• Foothills Grey Gum – Broad Leaved Mahogany; • Northern Wet Tallowwood – Blue Gum; • Wet Bloodwood – Tallowwood (Temperate Rainforest); • Wet Flooded Gum – Tallowwood; and • Hardwood Plantation.	122.58	65.05
RATIO of Cleared Vegetation to Retained Vegetation		**1.88 : 1**	

Note: all figures determined through GIS analysis based upon overstorey vegetation cover.

The protection area is at a ratio of approximately 1.88 : 1 as detailed in Table 9-14. In the protection area, fallen limbs, leaf litter and dead trees would be retained insitu for habitat purposes.

Firebreaks must be located outside the protection area wherever possible or along existing fire trails. The way in which fuel loads are to be managed in the protection area is dependant on the use and approval of fuel reduction.

24.3.14 Surface Water Mitigation Measures

- Works within the floodplain of the Nambucca River and South Creek would not be undertaken during high rainfall seasons.
- Temporary coffer dams are to be designed and constructed to accommodate the 1 in 10 year flood event.

24.3.15 Noise and Vibration Mitigation Measures

The following general measures are to be incorporated into the CEMP for the Proposal:

Construction

Work Ethics / Community Relations

- All site workers would be sensitised to the potential for noise impacts onto local residents and encouraged to take all practical and reasonable measures to minimise noise during the course of their activities; and
- The site manager (as appropriate) would establish contact with the local residents and communicate the construction program and progress on a regular basis, particularly when noisy activities are planned.

General Recommendations

As far as practicable, the following general noise control measures would be incorporated in the Construction EMP:

- Aim to minimise movements of equipment and personnel during noise sensitive periods, such as night time; and
- Staff arriving or leaving the construction work areas before 7 am or after 6 pm would be made aware of the potential for noise impacts at nearby receivers;
- All work would be kept within the working hours prescribed by the DECCW CNG. This includes trucks not arriving on construction work areas before 7:00 am. Should works out of these hours be needed, the work methods and noise goals of the DECCW's CNG would be considered;
- All equipment used on site would be in good condition and good working order;
- Use equipment, which is fit for the required tasks in terms of power requirements;
- All engine covers would be kept closed while equipment is operating;
- All combustion engine plant, such as generators, compressors and welders would be checked to ensure they produce minimal noise with particular attention to residential grade exhaust silencers;
- Vehicles would be kept properly serviced and fitted with appropriate mufflers. The use of exhaust brakes would be avoided, where practicable;
- Where practical, machines would be operated at low speed or power and would be switched off when not being used rather than left idling for prolonged periods;
- Machines found to produce excessive noise would be removed from the construction work areas or stood down until repairs or modifications can be made; and
- Should blasting be required on construction work areas, the activity would be subject to vibration controls stipulated in the Construction EMP.

Operation

General Recommendations

The following general noise control measures would be incorporated in the design of operational noise sources, such as pumping stations:

- All external noise sources would be located so as to avoid direct line of sight with noise receivers;
- If possible, ventilation or exhaust openings would not face noise receivers;
- Staff arriving or leaving the site for maintenance before 7 am or after 6 pm would be aware of the potential for noise impact at nearby receivers.

Mechanical Plant – General Advice

- Investigate the operational requirements for the mechanical systems and where practical, optimise the required operational time with consideration to potentially noise sensitive time periods, such as night;
- Equipment would be kept properly serviced;
- Where practical, machines would be operated at low speed or power and would be switched off when not being used rather than left idling for prolonged periods;
- Mechanical plant would be fully enclosed to minimise noise propagation; and
- All equipment would be vibration isolated, with consideration to manufacturers requirements.

24.3.16 Indigenous Mitigation Measures

The proposed management measures are to be incorporated into the CEMP for the Proposal:

- That the possible Aboriginal manuport (NWS1) be re-positioned near to its find location outside of any impact zone by local Aboriginal representatives and archaeologists prior to construction commencing within the storage area.
- As the NWPAD1 is to be impacted by the installation of the transfer pipeline, a program of archaeological subsurface investigation (and Section 87 permit under the NPW Act) would be undertaken with the aim of determining the nature, extent and significance of any subsurface archaeological deposit present within the area.
- To minimise potential delays in construction resulting from the identification of unidentified Aboriginal sites, it is proposed that after initial vegetation clearance within the storage, Aboriginal representatives and archaeologists would undertake an inspection of the storage area. This would provide an opportunity to locate and collect any sites that may not have been able to be seen during the field surveys. A section 87 permit would be required from DECCW to collect any identified sites.

24.3.17 Non-Indigenous Heritage Mitigation Measures

The proposed management measures are to be incorporated into the CEMP for the Proposal:

- Notification of the intention to impact the forestry stump, site NWSH1, would be provided in writing to the Director of the NSW Heritage Office with a request that a determination be made as to whether the intended impact falls under an existing exemption to section 139 permit provisions.

- No impact can occur until this advice is received and acted upon. This procedure is necessary because this site falls under the definition of a relic (as defined by the *Heritage Act 1977*), but has not been assessed as having local or a greater level of significance.

24.3.18 Traffic Mitigation Measures

It is proposed that the following mitigation measures are to be incorporated into the CEMP for the Proposal:

- That a comprehensive traffic management plan be prepared and submitted to the consent authority for approval detailing construction period transport activities, site access, parking and stockpile areas for the duration of the works.
- That MR 118 Rodeo Drive from Macksville to Bowraville would be the principal access route to the site from Pacific Highway and from areas to the south of Macksville.
- That the route from Nambucca Heads via Old Coast Road and Wirrimbi Road with an alternate route for heavy vehicles via Siding Road, to the Proposal site is an acceptable access route, subject to the development of an acceptable Traffic Management Plan.
- That if Wirrimbi Road is used as a materials supply route, that the signposted load ratings of the rail bridge be confirmed for the particular class of vehicle to be used.
- That the rail bridge and approaches on Siding Road be signposted in accordance with AS 1742.2.
- The design of the existing headworks access road to Bellingen Road would be upgraded to current standards.
- That the section of Bobo Road being used for access to the storage site be upgraded to a 6 metre formation with 3 metre wide bitumen seal.
- That vehicular access to Lot 2 DP 1076377 be maintained as part of any changes to road status and access routes associated with the acquisition of the storage site area by NSC.
- That NSC undertakes improvements to the delineation and signposting of the two railway crossings on MR 118.
- That the unsealed length of Valla Road be regularly maintained during the course of the works in accordance with a Traffic Management Plan including dust control, maintenance and intervention strategy approved by NSC.

24.3.19 Visual Amenity Mitigation Measures

The following mitigation measures are to be incorporated into the CEMP for the Proposal:

Access roads

- Seal Bobo Road to suppress dust.

Construction

- Liaise with affected property owners prior to and during construction to advise of progress and proposed treatments;
- Suppress dust as necessary;

- Do not allow waste to proliferate and clean up regularly;
- Remove redundant construction phase buildings and compounds; and
- Rehabilitate construction compound areas upon completion.

Operation

- Ensure the headworks building and power transformers are constructed to complement the surrounding rural landscape; and
- Grass or rock line the storage embankment so that it blends into the natural landform of the area.

24.3.20 Waste Management Mitigation Measures

The following mitigation measures are to be incorporated into the CEMP for the Proposal:

Table 24-4 Waste Management Measures

Waste Type	Waste Management Measures/Hierarchy		
	Avoid	Reuse/Recycle/Recovery	Treatment/Containment/Disposal
Construction			
Excavated Material	Design construction works to avoid excess excavation where possible	Excavated material would, wherever possible, be re-used on site. If this is not possible, the excavated material may be able to be reused as fill in another location. Topsoil would be reused in revegetation and rehabilitation of cleared areas.	Residue to appropriate DECCW approved clean fill landfill.
Vegetation Matter	Minimise the amount of clearing	Millable timber would be removed by DI&I as part of acquisition agreement with NSC. Remaining vegetative matter would be mulched and reused on-site. If this is not possible, the mulch would be used across the LGA for local revegetation works. Logs and tree limbs suitable for habitat and or fauna refuge would be collected during clearing and placed in a location identified as suitable.	Residue disposal to NWMF. Some material may be burnt on site.
Construction Waste	Construction materials would be sourced and ordered in appropriate quantities.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility.	Residue disposal to NWMF.
Miscellaneous Waste	Materials would be sourced and ordered in appropriate quantities.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility.	Residue disposal to NWMF.
Liquid Waste	Materials would be sourced and ordered in appropriate quantities. Dewatering would be minimised.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility. Dewatering water would be discharged locally providing it is adequate distance from waterways.	Residue disposal to NWMF. Human waste would be discharged to Bowraville sewage treatment plant.

The following operational mitigation measures are proposed:

Operation			
General Operation	Materials would be sourced and ordered in appropriate	Recyclable and non-recyclable materials would be segregated and transported to an appropriate	Residue disposal to NWMF.

Wastes	quantities	recycling or waste management facility.	
Liquid Waste	Materials would be sourced and ordered in appropriate quantities. Dewatering would be minimised.	Recyclable and non-recyclable materials would be segregated and transported to an appropriate recycling or waste management facility.	Residue disposal to NWMF. Sewage would be discharged to a licensed sewage treatment plant.

24.3.21 Hazards and Risks Mitigation Measures

The following mitigation measures are proposed:

24.3.22 Human Health

To minimise the potential human health impacts associated with construction and operation of the Proposal, the following mitigation measures would be implemented:

- A site Occupational Health and Safety Plan (OHS Plan) would be developed by the construction contractor prior to the commencement of works at the proposed development area. The OHS Plan would be developed to satisfy WorkCover requirements and would include the following information:
  - A safe system of work (work method procedures) for both construction and operation phases to ensure the health and safety of site personnel;
  - A contingency plan and emergency procedures to be adopted in situations which might arise and are not covered by normal OHS procedures; and
  - A list of site supervisors identifying their responsibilities with regard to OHS.
- Minimising operational fuel and chemical storage on the site. Where possible, fuels and chemicals would be transported to the site when required;

24.3.23 Social and Economic Mitigation Measures

The following mitigation measures are proposed:

Potential benefit or Issue	Management Measures
Property access	• Provision of traffic management procedures to manage access issues during construction.
Increased demand for rental accommodation - this may temporarily increase rental costs, particularly impacting on households with low and very low incomes.	• Where possible, construction workers would be sourced locally to minimise the number of workers needing to relocate to the Shire.
Increased demand for short-term tourist accommodation during construction.	• Ensure ongoing consultation and notification with local tourist accommodation providers and tourism development associations regarding accommodation needs, and peak periods of tourist accommodation demand (i.e. peak tourist season, festivals, etc)

Safety for road users during construction due to an increase in construction traffic, including heavy vehicles.	◗ Implement a construction traffic management plan (CTMP) to ensure safety for motorists and other road users is maintained. ◗ Communicate changes to local access and traffic impacts to local residents and tourists, including potential for delays and disruptions. ◗ Regularly monitor haulage routes during the construction period and repair damage caused by construction traffic.
Reduced amenity in Bowraville as a result of increase in heavy vehicles through town, reduced availability of car parking spaces and increased noise and exhaust fumes	◗ Minimise movement of heavy vehicles through town during business hours or identify alternate route as part of CRTMP. ◗ Contractor to minimise the parking of heavy vehicles in town during construction phase.
Access and movement patterns impacts on DI&I	◗ DI&I would have access to areas of State Forest land identified for acquisition to remove any harvestable timber within the footprint of the Proposal prior to commencement of construction.
Potential benefits for manufacturing industries in the Shire, which may provide materials for construction.	◗ Where possible, construction materials would be sourced from local industries and manufacturers.
Impact on residential amenity, including increased noise and dust.	◗ Ongoing consultation with local residents in the vicinity of construction works would be undertaken to ensure potential impacts are identified and appropriately managed. ◗ Provision of appropriate noise management measures during the construction and operational phases. ◗ Appropriate environmental controls during construction in order to maintain the environmental amenity of the surrounding environment: • Water quality / detention basins. • Dust management measures. • Blasting and noise control measures

Restriction on use of land surrounding the inundation area.	◗ Communicate potential restrictions on land use and farming and land management practices for properties surrounding the inundation area.
Change to property access	◗ Access to individual properties would be maintained. ◗ Early consultation would be undertaken with property owners whose access may be altered to ensure potential issues are appropriately managed.
Increase in water rates on residential user bills	◗ Communicate potential increase in rates to all users and the benefits of a secure water supply.

Recreational Management Measures

Given the potential for decreased water quality and contamination of the water supply, motorised boats, water skiing and jet skiing, canoeing, and fishing would not be permitted within the storage.

24.3.24 Utilities and Infrastructure Mitigation Measures

The following mitigation measures are to be incorporated into the CEMP for the Proposal:

- The proposed on-site amenities at the headworks and viewing area are to be designed in accordance with current best practice to meet NSC requirements.

24.3.25 Land Use Mitigation Measures

Construction

Construction impacts would be minimised where possible through the development of construction, environmental and traffic management procedures and systems. Some management measures may include:

- Maintaining property access for the duration of construction. The construction contractor would consult with individual landowners would temporary property access be required.
- Providing property owners with advanced notification of project schedules, construction works and changes to access arrangements.
- Separate approvals would be required for construction compounds/ temporary holding yards during the detailed design phase.
- Separate approvals would be required for augmentation of the electricity network to service the Proposal during the detailed design phase.

Operation

- Prior to acquisition of land dedicated under the *Forestry Act 1916*, such as a state forest, revocation of the land in accordance with the Act must first be affected by one, or a combination of the following means:
  - Act of Parliament – where the land affected (irrespective of the area) is zoned by Forests NSW for conservation purposes.
  - Resolution of both Houses of Parliament – where the land affected is not zoned for conservation purposes and exceeds 20 hectares.
  - Notice in the Government Gazette – where the land affected is not zoned for conservation purposes and does not exceed 20 hectares.
- Negotiations with affected landowners for the use of the land (via easements) affected by the borefield collection system, transfer pipeline, access and power augmentation would be undertaken during the detailed design phase.
- Compulsory acquisition of land would only be negotiated with affected landowners if satisfactory arrangements can not be reached and then in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. The objectives of the *Land Acquisition (Just Terms Compensation) Act* are to:
  - Guarantee that, when land affected by a proposal for acquisition by an authority of the State is eventually acquired, the amount of compensation would be not less than the market value of the land (unaffected by the Proposal) at the date of acquisition.

- Ensure compensation on just terms for the owners of land that is acquired by an authority of the State when the land is not available for public sale.
- Establish procedures for the compulsory acquisition of land by authorities of the State to simplify and expedite the acquisition process.
- Require an authority of the State to acquire land designated for acquisition for a public purpose where hardship is demonstrated.
- Encourage the acquisition of land by agreement instead of compulsory process.

LEP Amendments

- The *Nambucca Local Environment Plan 1995* would need to be amended to reflect the change in land use of the Proposal from its current 1(f) Rural (Forestry) zoning to a more appropriate zone such as RU1 Primary Production or SP2 Infrastructure as part of the draft Local Environmental Plan (LEP).
- In order to protect the water quality within the catchment, development on surrounding land would be managed by the *Nambucca Local Environment Plan 1995* or new draft LEP to ensure that water entering the system does not adversely affect water quality. NSC would review water quality protection measures as part of future LEP and DCP amendments. This would include consideration of an overlay linked to local land use provisions.

24.4 Draft Construction Environmental Management Plan Outline

24.4.1 Overview

The Draft CEMP is presented within the EIS, on the understanding that a detailed CEMP for construction, as well as relevant environmental plans are to be prepared by the Contractor and reviewed by NSC and DECCW. The detailed CEMP for construction would need to include, but not be limited to, mitigation measures that address the Environmental Objectives and Performance Criteria of this Draft CEMP and any conditions imposed either by the determining authorities. They would also need to refer to expressed community needs and issues as identified during the public exhibition period.

The purpose of the CEMP is to set out the Proposal's commitments to avoid or minimise potential environmental impacts of the Proposal as identified in the EIS, including identification of environmental aspects to be managed and how environmental values may be protected and enhanced.

The CEMP would be updated to incorporate further information, approval conditions, and changes in environmental management procedures in the light of ongoing monitoring results, new techniques, and relevant legislative requirements.

24.4.2 Implementation

The CEMP demonstrate show potential impacts may be addressed during the construction phase of the Proposal. The preparation of specified actions, strategies and recommendations implemented through the CEMP includes:

- Mitigation and management measures made in the EIS to minimise identified environmental impacts;
- Good practice environmental management;
- General content requirements of international standard ISO 14001; and
- Management and responsibility for performance.

24.4.3 Purpose

An CEMP is a management tool used to assist in minimising impact to the environment. The CEMP is a dynamic document. It would be regularly updated to incorporate changes in environmental management procedures in the light of ongoing monitoring results, new techniques, legislation and environmental policies of the proponent in consultation with the relevant authorities.

The implementation of the CEMP would ensure that concepts and commitments given in the EIS are applied so that the potential impacts of the construction and operation of the proposed infrastructure on the environment are minimised.

The CEMP provides for ongoing environmental performance review and compliance monitoring.

24.4.4 Environmental Requirements and Obligations

The Draft CEMP is devised to ensure that identified environmental impacts relating to the Proposal's construction and operation are avoided or minimised. In this regard, the Draft CEMP may refer to environmental legislation, controls, standards and guidelines relevant to impact mitigation and avoidance. The Draft CEMP would require that, wherever possible, works related to site development meet environmental expectations of the broader and local community.

A list of applicable legislation is identified in Section 24.1.

24.4.5 Objectives and Principles

The objectives of the CEMP are those embodied in the Intergovernmental Agreement on the Environment (IGAE) and the Principals of Ecologically Sustainable Development (ESD).

The Core Objectives are:

- To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- To provide for equity within and between generations; and
- To protect biological diversity and maintain essential ecological processes and life support systems.

The Guiding Principles are:

- Where there are threats of serious or irreversible damage, lack of full scientific certainty would not be used as a reason for postponing measures to prevent environmental degradation;
- The global dimensions of environmental impacts would be recognised and considered; and

- Decisions and actions would provide for community involvement regarding issues that affect them.

No objective or principle would dominate others. A balanced approach which takes into account all of these objectives and principles is required to pursue the goal of ESD.

24.4.6 Environmental Responsibilities

Management Structure

To achieve the over-arching objective of sound environmental management and deliver the Proposal with the least possible impact on the local community, a clear implementation and management structure is required.

The proposed structure, regardless of the contractual delivery mechanism adopted for the Proposal, includes the following roles.

NSC:

- Proponent for the Proposal.
- Regulates the performance of the works.
- Acts to facilitate the expression of community views.
- Owner of the land required for the inundation area.

Project Manager (may also be NSC):

- Administrator of the head agreement or contract to ensure that the contact conditions are met;
- Liaise with and coordinate relevant agencies within the NSW Government to provide timely advice to the Contractor for the smooth and efficient delivery of the Proposal.
- Ensure that prior to commencement of any work the Contractor/s have obtained all necessary approvals, established and properly briefed the community, particular affected landowners and agreed to a schedule of regular meetings.
- Ensure that the Contractor is operating in accordance with the CEMP and in compliance with all applicable approvals and licensing.

Consultant/ Contractor:

- Prepares detailed engineering designs and CEMP.
- Obtains all necessary approvals, including development approvals, environmental licenses, workplace health and safety and all other construction-related approvals.
- Ensures all designs and construction works are prepared and conducted in accordance with approvals, with the contract, with relevant legislation and regulations, and with local laws.
- Maintains for the duration of the construction phase, open and effective communications with the communities in the vicinity of the works areas about the construction program, scale, duration and nature of the proposed work, and details of proposed impact mitigation measures.

24.4.7 Competence, Training and Awareness

The CEMP would only be successful where all those responsible for its implementation and review are thoroughly conversant with its content, interpretation and performance measurement. NSC is committed to providing training for its site workforce and ensuring that the contractual arrangements with the contractor specify the need for adequate training to be provided to all contracted members of the storage workforce.

Staff involved in environmental monitoring would be trained and competent in the operation, calibration and maintenance of the equipment. Sampling staff would also be trained and competent in sample collection, handling, storage and transport methodologies and techniques.

Records of staff training would be auditable and available for inspection, on request.

24.5 Documentation, Communication & Complaints

24.5.1 Documentation and Environmental Records

Adequate records must be maintained to demonstrate compliance with the CEMP. These records would be available at all times and readily accessible for independent inspection and audit. This includes:

- Contract documents;
- Statutory permits and licences;
- Reports;
- Monitoring data results;
- Environmental audits and reviews;
- Environmental training records;
- Details of non-conformance reports;
- Complaints register;
- Inspection, calibration and maintenance activity; and
- Corrective action reports.

The following documents must be readily accessible for personnel to carry out the activities associated with the Proposal:

- A copy of the CEMP;
- Copies of environmental checklists and forms required by the CEMP;
- Copies of relevant work instructions and procedures;
- Material Safety Data Sheets (MSDS) for any chemicals stored or used on the site; and
- copies of permits, approvals and attached conditions.

Modifications to the records keeping system shall be done to ensure it is effective and efficient for all levels of employees involved to ensure compliance with the requirements of the CEMP.

24.5.2 Internal Communication

Environmental protection would be achieved through clear and concise internal communications, which would be subject to periodic audits to ensure that the communication structure is performing adequately and all actions are performed and recorded. The audits would also provide for followup on specific or corrective actions raised during previous audits to ensure responses are complete.

The CEMP would be held in a prominent location and would include at the start of the document a list of the names, affiliations, phone numbers and fax numbers (including after hours numbers where necessary) of the people within the designated environmental management reporting structure.

The Contractor would submit the following as part of their Monthly Report to NSC containing a summary of:

- Works undertaken;
- Monitoring results;
- Compliance with approvals, licences and the CEMP;
- Complaints; and
- Corrective actions and contingency, and success of implemented measures.

Significant communications, including all reports, incident forms and complaints would be documented and kept up to date.

24.5.3 External Communication

To ensure external communication is timely and transparent, only nominated personnel would be involved in consultation with external bodies on environmental issues. The Project Manager is responsible for nominating all staff members responsible for external communication. The Project Manager may also invite personnel to attend meetings with agencies and the community consultative committees.

Any incidents and environmental harm during construction works or operation of the storage would be reported to the DECCW as soon as possible.

24.5.4 Complaints and Responses

The environmental management process managed by the Contractor is to include a procedure for receiving and acting upon complaints. Attention to complaints would be carefully managed, prompt and effective, and would form a key part of the environmental reporting mechanism.

Responsibility for maintaining the complaints procedure would rest with the Project Manager.

While the CEMP would establish the procedure for complaints, basic requirements would include:

- A procedure for receiving and responding to complaints which is acceptable to NSC and the DECCW;

- The Contractor maintaining, during the construction phase, a complaints telephone service (24hr / 7 days Customer Contact number);
- A process for registering and handling all complaints received in terms of:
  - time and date of complaint;
  - the identity of the complainant and the recorder of the complaint;
  - the specific action or activity causing the complaint;
  - whether environmental compliance requirements are being met;
  - the action taken to address the complaint if necessary;
  - a database for tracking of complaints and actions taken in response;
  - immediate communication of the complaint to the contractor;
  - details on how the action taken is to be communicated to the complainant and the Proponent and the Contractor;
  - feedback to the complainant and NSC, and as required the DECCW within a specified time period;
  - any subsequent remedial action required to avoid cause for future complaints if relevant;
  - regular reporting to DECCW and NSC on complaints and corrective actions; and
  - monitoring and auditing of the complaint handling system.

Other informative resources are also to be accessible by external stakeholders via the NSC website that would also offer feedback forms for complaints and grievances.

24.5.5 Monitoring

Measuring, monitoring and evaluating would be key activities of each element within the CEMP. Monitoring shall mean the setting in place and operation of various procedures to monitor, measure and record the level of impact on the environment during the execution of the Proposal.

The monitoring of environmental impacts shall be carried out in accordance with the monitoring requirements for each element throughout the CEMP, relevant legislation and the conditions of any permit, where relevant.

Monitoring procedures would be developed in accordance with standard protocols and the requirements of the DECCW, DI&I and other relevant agencies as appropriate. All equipment used for environmental monitoring would be calibrated and maintained to the standards recommended by the supplier/manufacturer. Records of calibration and maintenance for each piece of monitoring equipment would be held on site.

Environmental monitoring samples, if taken, would be sent for analysis to a National Association of Testing Authorities (NATA) registered laboratory where applicable. All records of laboratory analysis results and quality assurance would auditable and available for inspection, on request, by regulatory agency officials or their representatives.

The proposed monitoring requirements for the Proposal during construction are outlined in Table 24-5.

Table 24-5 Monitoring Requirements – Construction

Issue	Requirements	Location	Frequency	Parameters	Responsibility
Air Quality	Real time dust (PM_{10}) monitoring at receiver to the south-west of storage and visually monitor dust generation at other sites.	Construction Site	Daily	Visible Dust	Contractor(s)
	Inspect site to ensure dust control measures are implemented.	Construction Site	Daily	N/A	As above
	Grass coverage and surface material to be re-established as appropriate.	Construction Site	Three months after seeding; and One month after completion	Grass established	As above
Erosion and Sediment Control	Erosion and sediment control measures are installed prior to commencement of works.	Work area and work area boundaries	Prior to commencement of works	Checked against ESCP	As above
	Inspect erosion and sediment control measures to ensure installation and efficient operation.	Where measures installed	Weekly and within 24 hours of storm event that generates runoff	Proper functioning of installed measures	As above
	Inspect vehicles leaving site to ensure they have been cleaned of mud etc	Entry/Exit Point	Daily	Presence of mud on vehicle / road	As above
Flora and Fauna	Pre-clearance survey prior to the commencement of proposed clearing activities.	Storage area	2 weeks prior to clearing	Mark habitat features suitable for transferral to the offset area (eg large logs, boulders), mark hollow trees, mark Koala food trees	As above

Issue	Requirements	Location	Frequency	Parameters	Responsibility
Surface Water	Visual inspection of water quality	From watercourses downstream of construction site	Daily	Appearance of receiving waters.	As above
	Collect and analyse surface water samples (from Coffer Dams and downstream within Bowra Creek)	From watercourses downstream of construction site	Following event	Total Suspended Solids; Total Nitrogen; Total Phosphorous; and pH.	As above
Noise	Construction machinery and equipment maintained and operated in accordance with manufacturers' requirements.	Construction Site	Prior to construction; As required.	Records of maintenance retained and maintenance completed as required	As above
	Construction machinery and equipment operated only during the operating hours (7am to 5pm Monday to Friday, 8am to 5pm Saturday, Sunday).	Construction Site	Daily	Hours of operation of construction machinery and equipment	As above
Waste Management	Ensure wastes are divided into appropriate waste streams	Construction Site	Daily	Recyclable, Reusable and Disposable Waste Systems	As above
	Monitor site-specific waste management procedures to ensure compliance	Waste Areas	Weekly	N/A	As above
Employee and Public Safety	Requirements of OHS Plan implemented	Construction Site	Daily	Check against OHS Plan	As above
Social Impacts	Review any complaints received	Project Manager/ Construction Contractor Office	Following receipt of complaint	Against findings of EIS and Construction EMP; and Against approval requirements.	As above
	Address any complaints received	Project Manager/ Construction Contractor Office	Within two weeks of receipt of complaint	Measures to address complaint implemented; and Response provided to complainant	As above

24.5.6 Auditing

Aspects of the Proposal with a potential for environmental impact would be subject to periodic environmental audits. The audit objectives would be to verify compliance with applicable Commonwealth, State and Local government environmental permits, approvals and regulations issued for the Proposal.

The audit would also seek to verify the suitability of the CEMP.

Each audit would be internally reviewed by management and all recommendations / actions raised would be addressed. Copies of audit reports and details of corrective actions would be made available for regulatory inspection, on request.

24.5.7 Reporting

Monthly environmental summary reports would be produced for the duration of the works. Copies of the reports shall be held on site and would be available for regulatory agency inspection, on request.

The report shall include, but is not limited to the following:

- Record of inspections;
- A list of any performance criteria that have not been met, the corrective action taken and a description of the magnitude of any possible environmental impact;
- A register of complaints detailing:
  - origin of the complaint;
  - complaint investigation (personnel, date and summary of action/s taken); and
  - response to actions and suggested changes to practices or procedures.
- Results of any surveys carried out;
- An annual Environmental Summary Report would be prepared each calendar year by the Operator (for the first five years of operation), containing, in part, the following information:
  - summary of the monthly Environmental reports;
  - fluctuations in water storage levels;
  - releases; and
  - water quality monitoring.

24.5.8 Non-compliance and Corrective Actions

The monitoring and reporting would incorporate continual improvement in requirements identified through a non-compliance and corrective action procedure. These would be nominated in the Proposal's quality procedures and CEMP, and would specify methods for recording and reporting non-conformances and ensuring that corrective actions are implemented to rectify the problem.

24.6 Operational Monitoring

As documented in Chapter 4 – Description of Proposal, an adaptive management framework is proposed to minimise any potential impacts on the aquatic ecosystem downstream of the expanded borefield. Indicative operational adaptive management monitoring locations are shown in Table 24-6 whilst indicative operational adaptive management monitoring parameters, effort, triggers and responses are detailed in Table 24-7. The parameters, effort, triggers and responses would be subject to further negotiation between NSC and relevant government agencies prior to formal adoption.

It is envisaged that after up to 2 years of sampling or upon the formulation of a reasonable statistical baseline, that the frequency and locations of the monitoring shown in Table 24-7 could be reviewed subject to agreement between NSC and relevant government agencies.

It is proposed that a River Monitoring Committee be established as a Council Committee. This committee would be formed as an expert panel at which the monitoring regime would be reviewed and amended/adjusted based on the outcomes of the monitoring. The indicative sample locations and monitoring areas as setout in the EIS, would be subject to this panel's review.

Table 24-6 Indicative Operational Adaptive Management Monitoring Locations

Program	Locations (suitability of the sites would be assessed annually)	Number of monitoring sites
Water Quality/ Flow	Nambucca River North Arm - 1 upstream, 1 downstream and 1 within the target area.	3
Water Quality/ Flow	South Creek South Arm - 1 upstream, 1 downstream and 1 within the target area.	3
Water Quality/ Flow and Surface water and Instream ecosystem health	Nambucca River at Bowraville - 3 downstream of confluence with South Creek, from Lanes Bridge at 1 km intervals.	3
Water Quality/ Flow and Surface water and Instream ecosystem health	Reference Site - 2 sites on a similar system in an adjacent catchment.	2

Table 24-7 Indicative Operational Adaptive Management Monitoring Parameters, Effort, Triggers and Response

Parameters Monitored	How to monitor	Number of Sampling Locations	Effort	Frequency	Triggers/ Indicators	Response to Indicators
River Flow	Gauging stations	Check with BOM	OFFICE: Download from BOM, upload to a Council data base (1 hour)	Weekly	Reduction in flow to 20ML/day	No pumping. If statistical trend analysis suggests that there are downward trends in flows, modifications would be made to the scheme and/or flow rules.

Parameters Monitored	How to monitor	Number of Sampling Locations	Effort	Frequency	Triggers/ Indicators	Response to Indicators
River Water Quality	Hand Samples	15	FIELD: Collection of samples, 1 person, 15 mins at each site (total of 5 hours) LAB: Analysis of 15 samples OFFICE: Entry into spreadsheet and upload to Council data base (2 hours)	Monthly Sample collection is proposed for the first year of operation of the Proposal. Based on water quality trends, monitoring may be relaxed to quarterly after this time.	Site specific assessment criteria, based on the 80th percentile concentrations/levels from available historical data, can be used as early warning triggers that there may be impacts to the groundwater resource. Water samples would be analysed for pH, electrical conductivity (EC), total dissolved solids (TDS), major cations/anions, dissolved heavy metals (including aluminium, arsenic, cadmium chromium, copper, iron, lead, mercury, zinc), total nitrogen and total phosphorus.	If statistical trend analysis suggests that there are upward trends in concentrations of toxicants and stressors, modifications would be made to the scheme and/or flow rules. If in association with reduced flow or water level, monitor all parameters during and after reduced pumping until parameters are within the 95% confidence interval of the monthly mean prior to the trigger value being reached.
Water Level	Gauging stations and surveyed water levels during sampling rounds.	2	FIELD: Collected at same time as water quality data, approximately 5 mins at each site (total additional 1 hour) OFFICE: Data entry and upload to Council data base (1 hour)	Monthly	If groundwater levels fall to the 20th percentile level from available historical data, it is considered that this is an early warning trigger that there may be impacts to the groundwater resource and changes to the management action (flow rules) may be required.	Statistical trend analysis would be carried out to test whether a downward trend in water level exists and, if so, whether it is due to the borefield augmentation. If groundwater levels are reduced to 1 m above the base of the aquifer, there is a high risk of saline intrusion and subsequent impact on riparian/aquatic vegetation and modifications would be made to the scheme and/or flow rules.

Parameters Monitored	How to monitor	Number of Sampling Locations	Effort	Frequency	Triggers/ Indicators	Response to Indicators
Macrophytes	Qualitative assessment of macrophytes at artificial substrate sites, consistent with methods used by Bishop (2005).	4 sites, 3x10 m substations at each site	FIELD: Assessment of instream habitat, 2 people, each substation 15 mins = 45 mins per site (total 6 hours) OFFICE: Data analysis, data entry and upload to Council data base (3 hours)	Quarterly Sample collection is proposed for the first 2 years of operation of the Proposal. Based on trends, monitoring may be relaxed to biannually after this time.	All macrophytes are considered as indicator species. An indicator of saline encroachment is the decrease in abundance and distribution of macrophyte mats. Consideration is to be given to the influence of tidal saline waters that are known to push up to Lane's Bridge on the last three king tide events annually. Data is to be logged against tidal data and water quality to assess the saline influence.	To date there is not sufficient background data to determine if changes to macrophyte beds would be due to natural downstream impacts from king tide movements at three known intervals in one annual cycle, regular flood events or the natural die back of these plants. Monitoring to occur for up to 5 years, with frequency reviewed annually. Data to be reviewed at this point to assess if changes recorded are due to environmental flows and salinity. If die back occurs during periods outside of king tides, water quality data (salinity) and flow data to be reviewed and monitored. Once a more robust data set is collected, the data is to be reviewed to assess the patterns of abundance and distribution and assess the need for higher environmental flows.

Parameters Monitored	How to monitor	Number of Sampling Locations	Effort	Frequency	Triggers/ Indicators	Response to Indicators
Macroinvertebrates	Collection of artificial substrates.	4 sites, 3 artificial substrates at each site	FIELD: Collection, resetting and live picking of traps and animals, 2 people at same time as macrophytes, each substrate 30 mins live pick time = 1 hours per site (total 4 hours) LAB: Inverte Ids of live picked animals, 45 mins per sample including data entry (5 hours) OFFICE: upload to Council data base (2 hours)	Quarterly Sample collection is proposed for the first 2 years of operation of the Proposal. Based on trends, monitoring may be relaxed to biannually after this time.	Particular saline tolerant invertebrate families are known to occur in the Nambucca River, this includes Isopoda Sphaeromatidae. The presence of this animal is an indicator of saline encroachment and/or the movement of saline fish into the system (these animals can be parasitic to marine fish). Freshwater species of mayflies, dragonflies, damselflies and caddis flies can be used as indicators of harsh conditions include salinity as all these families have very low tolerance to pollution (including salinity).	Invertebrate data is to be reviewed with the water quality data, slight changes in the salinity can cause changes to the community composition for the instream invertebrates which in turn can reduce the lower trophic levels of food availability. Invertebrate data can be used as a guide to aquatic health but would be assessed with the water quality data to determine if salt intrusion has caused die back or changes in community composition. Annual changes in water availability and natural life cycles would also affect the community composition of bugs. Once a more robust data set is collected, the data is to be reviewed to assess the patterns of community composition and the need for higher environmental flows.

Part F Conclusion

25 Project Justification and Conclusions

25.1 Justification for the Proposal

The drought of 2002/2003 highlighted that the Nambucca and District Water Supply Scheme is highly vulnerable to drought. During this period, it was estimated that as little as 60 days' water supply may have been remaining within the system. To address this issue, NSC has determined that in addition to the demand management strategies outlined in the IWCM Strategy, additional water supply security is required as soon as possible. Additional water security would provide Shire residents and businesses with an increased level of drought security. The Proposal also provides additional benefits in securing environmental flows for the Nambucca River.

The IWCM Strategy proposes a number of demand management strategies including effluent recycling, an enhanced tune up/ retrofit program focusing on water efficient washing machines and cisterns, a rain water tank refit program, a grey water rebate program, an enhanced system leakage reduction program, an enhanced system leakage reduction program and distribution mains upgrades.

In addition to providing increased water security to Nambucca's current population there is also a need to consider projected population increase as this would result in an increase in demand for urban water services. The *Nambucca Shire Structure Plan* (NSC, 2008) estimates the population in the Nambucca LGA would grow by approximately 2 percent per annum over the next 20 years. The Plan estimates by 2026 the population would grow to 26,593 persons (8,697 additional persons from 2006). The IWCM Strategy (NSW WS, 2009) further projects that by 2046 the population would reach 29,943 with an annual growth of 1.6 percent per annum.

The projected increase in population growth over the next forty years would result in an increase in demand for the existing urban water services. The existing system is unable to accommodate such an increase in demand and therefore the system requires augmentation to protect the current and future population of the Nambucca LGA.

25.2 Proposal Benefits

The key benefits of the Proposal are as follows:

- Remove the risk of substantial water restrictions being employed for long periods of time;
- Facilitate local population growth, remove uncertainty and cater for investment in the LGA. This would encourage the creation of jobs both directly during construction and indirectly by supporting the LGA's population growth;
- Help avoid environmental impacts associated with the potential over-use of water resources within the Nambucca River;
- The Proposal greatly reduces the economic consequences of reduced water supply on local businesses reliant on a secure water supply for on-going operations;
- In severe drought periods, the Proposal greatly reduces the likelihood of business and industry from being shut down to conserve water for essential household supply;

- The Proposal significantly reduces the risks associated with the community being forced to invest in emergency drought measures with unknown costs and uncertain feasibility;
- The Proposal represents a well researched and cost effective solution, compared to other potential water supply options; and
- The Proposal represents the most ecologically sustainable solution compared to other potential water supply options identified for the Nambucca LGA.

25.3 Ecologically Sustainable Development

One of the key issues in the Director-General's requirements relates to strategic justification of the Proposal with respect to the principles of ecologically sustainable development.

In accordance with the *Protection of the Environment Administration Act 1991* (PEA Act), ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following four principles:

- The precautionary principle.
- Inter-generational equity.
- Conservation of biological diversity and ecological integrity.
- Improved valuation, pricing and incentive mechanisms.

This Chapter defines these principles and describes how they have been applied to the Proposal.

25.3.1 Precautionary principle

The PEA Act defines the precautionary principle as *"if there are threats of serious or irreversible environmental damage, lack of full scientific certainty would not be used as a reason for postponing measures to prevent environmental degradation"*.

Further, the PEA Act states that, in applying the precautionary principle, decisions would be guided by:

- Careful evaluation to, wherever practicable, avoid serious or irreversible damage to the environment.
- An assessment of the risk-weighted consequences of various options.

The precautionary principle has played a key role in the development of the Proposal, from the option identification and assessment process through to the concept design and the EIS. Appropriate information was obtained for each phase of the development process to allow potential impacts to be identified, an informed assessment process to be undertaken and appropriate management measures to be developed. This includes:

- Developing the Proposal using a number of different phases of investigation, consultation and assessment to ensure that on balance the most appropriate option was selected. Those phases were:

- An options development phase, which included preliminary environmental, cultural, engineering, economic and social investigations of the Proposal, as well as some targeted investigations.
  - Concept design development, which further refined the preferred option based on detailed investigations of a number of environmental and social issues associated with the Proposal.
  - EIS development, which built on earlier investigations and consultation. This assessment was based on the Director-General's requirements and informed by field investigations.
- Undertaking an environmental risk analysis to ascertain whether aspects of the Proposal required a higher level of study than that required by the Director-General's requirements. The environmental risk analysis confirmed the level of assessment required, and facilitated the adoption of the precautionary approach for the EIS and the concept design.
- Selecting and adjusting the concept design for the Proposal to avoid or minimise:
  - Vegetation clearing within sensitive areas, particularly the Viewmont State Forest.
  - Potential impacts on threatened flora and fauna, as well as key habitat areas.
  - Potential impacts on known items or areas of Aboriginal cultural significance.
- Identifying possible constraints of the Proposal associated with soil conditions such as high dispersivity, and the identification of appropriate vegetation clearing sequencing and management measures to minimise soil erosion and improve water quality within the storage.
- Developing management measures for threatened flora and fauna species and endangered ecological communities in known or potential habitat areas identified during field investigations. This has included measures such as offsets.
- Minimising potential impacts on existing rural and rural-residential properties and other land uses.
- Undertaking extensive community consultation throughout the development process for the Proposal. This was aimed at identifying the potential environmental and social issues so that they could be assessed and management measures developed to address these issues where necessary.

25.3.2 Intergenerational equity

The PEA Act defines intergenerational equity as the present generation ensuring that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

The Proposal would provide a number of benefits to current and future generations of the LGA that would maintain or enhance the health, diversity and productivity of the environment. This includes:

- Selecting a location for the storage that minimises vegetation clearance within sensitive ecological areas, ensuring that such areas are conserved for future generations.

- Water quality, fauna habitat and hydrological measures into the Proposal to ensure that the impacts on the distribution of sensitive ecological areas and other areas of terrestrial and aquatic habitat are minimised both for the short and long term.
- Offset measures including the identification of compensatory habitat around the storage to mitigate against the vegetation clearing required for the Proposal.
- Detailing management measures and monitoring programs for the construction and operation phases of the Proposal to help control and minimise the potential for long-term environmental and social impacts that could arise during these phases.
- Consulting with DECCW and the local Aboriginal community throughout the option selection process and the EIS phase sought to minimise the potential for irreparable damage to Aboriginal cultural heritage during the construction. Ongoing involvement of DECCW and the local Aboriginal community during the construction phase would further reduce the potential for damage to Aboriginal cultural heritage.

25.3.3 Conservation of biological diversity

The PEA Act states "*conservation of biological diversity and ecological integrity would be a fundamental consideration*".

Biological diversity is defined by the TSC Act as "the diversity of life and is made up of the following three components:

"(a) Genetic diversity - the variety of genes (or units of heredity) in any population,

(b) Species diversity - the variety of species,

(c) Ecosystem diversity - the variety of communities of ecosystems."

Ecological integrity is not defined by any Australian legislation. However, ecological integrity is defined by the Canada *National Parks Act 1974*, as "*a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes*".

Conservation of the biological diversity of the local area has been a key issue during the option identification and selection process, the concept design development and the EIS phase. This includes:

- Identifying and mapping in the initial phases of the option selection process of known areas of high biodiversity significance, areas of threatened species habitat, potential endangered ecological communities and mapped fauna movement corridors. This information was confirmed from existing vegetation community mapping, DECCW databases, and subsequent field surveys. It formed a key component of the option selection process by providing constraints for the identification of the option that had the least impact on these areas and best protected the ecological integrity of the area as a whole.
- Undertaking further detailed field surveys during the concept design and EIS phase to determine the potential impacts of the Proposal. This facilitated the amendment of the concept design to minimise potential impacts and allowed for the development of appropriate management measures to mitigate against those impacts.

- Proposing a number of management measures to be implemented prior to, during and following construction, and continuing in the operation phase, with the purpose of minimising impacts on native fauna species, and therefore maintaining biological diversity.
- Designing and locating pipelines to minimise disturbance of riparian vegetation and avoid river and creek beds.
- Detailing a range of management measures to minimise the potential impact of the Proposal across a range of environmental aspects such as noise, air and water quality, as well as waste management that would also play an important role in the protection of the biological diversity and ecological integrity of the area.
- Considering the cultural significance to the local Aboriginal community of the remaining areas of native vegetation and the maintenance of the existing biological diversity of the area.
- Including a biodiversity protection area in the order of 1.88: 1 to mitigate any residual impacts of the Proposal.

25.3.4 Improved valuation and pricing of environmental resources

The PEA Act states that environmental factors would be included in the valuation of assets and services. The PEA Act identifies that the following can help achieve this:

- Polluter pays – those who generate pollution and waste would bear the cost of containment, avoidance or abatement.
- The users of goods and services would pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.
- Environmental goals, having been established, would be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The economic values of environmental resources affected by the Proposal have been taken into account throughout the option development process, the concept design development and the EIS phase. This includes:

- Considering environmental issues in the option development process.
- Costing the management measures required to minimise potential impacts on the environment as a result of the Proposal.
- Considering the potential economic impacts on affected property owners including the reduced viability of farming activities due to the loss of land, changes in access and property management practices associated with the Proposal.
- Recognising the economic value of state forests and ensuring that the area of state forest land directly affected by the Proposal or isolated from the main section of the state forest estate is minimised.

- Acknowledging that NSC and its construction contractors would be responsible for costs associated with the appropriate management of waste generated during construction of the Proposal.

25.3.5 Summary

The Proposal has considered the principles of ecologically sustainable development throughout the option selection, feasibility and concept design phases. Design decisions have been made with the aim of locating elements of the Proposal so that environmental impacts would be minimised. This has included amending bores and the associated collection system to avoid culturally sensitive areas and reducing impacts on agriculturally productive lands.

The Proposal would also meet the requirements of the four principles of ecologically sustainable development through the implementation of environmental management measures and appropriate offsetting developed in Chapter 9.

25.4 Conclusion

- The EIS has been prepared by GHD on behalf of NSC to assist the assessment of the likely environmental impacts of the Proposal. The EIS has been prepared in accordance with the provisions of the EP&A Act and EP&A Regulation.
- The EIS has assessed the potential environmental, social and economic effects of construction and operation of the Proposal. This included the potential impacts on air quality, soils, landform stability and erosion hazard, flora and fauna, groundwater and surface water quality, noise, heritage, traffic, visual amenity, waste management, hazards and risks, socio-economics, utilities and infrastructure, land use and climate change/ greenhouse gas emissions. Potential cumulative impacts and the principles of ESD were also considered.
- The EIS concludes that the potential adverse impacts of construction and operation o the Proposal could be mitigated through the implementation of appropriate mitigation and management measures. The Proposal would be supported subject to the implementation of the mitigation and management measures identified in this EIS.

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