Oxley Creek Transformation – An overview of waterway issues and restoration strategies

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- Oxley Creek Transformation Project is providing the catalyst for change regarding the health of the Oxley Creek corridor, from an environmental, social, and economic perspective
- The corridor and catchment have historically experienced significant environmental issues, with the current condition of the creek being a legacy of these.
- The project has developed several strategies that aim to improve the health to allow for future environmental, social, cultural, and economic opportunities.

Abstract

Oxley Creek is a major tributary of the Brisbane River. It is Brisbane’s largest catchment and much of the creek’s lower reaches are contained within the Brisbane boundary, so the creek has played a significant role in Brisbane’s growth, which has resulted in it being one of its most urbanised and polluted waterways. Historically, this has included activities such as vegetation clearing, sand mining, wastewater treatment and industrial activities that have impacted on the creek's stability, water quality and ecological health. Despite the considerable issues Oxley Creek faces, parts of the corridor still hold high ecological habitat and corridor values.

Because of the above, and Brisbane City Council’s recognition of the potential of the Oxley Creek Corridor, Council established the Oxley Creek Transformation Pty Ltd to guide and deliver the long-term vision to create a master planned legacy for Brisbane. Ideas to transform Oxley Creek into a world class green recreation corridor have been captured through local community and industry engagement, and informed by technical studies addressing biodiversity, flooding, stormwater, morphology, landuse, accessibility, economics and cultural heritage. These future visions of the creek have guided the preparation of master plan strategies which address the many challenges and opportunities ahead. The paper presents a summary of the master plan, with specific reference to issues related to catchment, waterway, and water management, and the strategies to overcome these.

Keywords

Strategic planning, stream restoration, South-East Queensland, Oxley Creek Transformation

Introduction

Oxley Creek is a major tributary of the Brisbane River, flowing 70 km from Mount Perry to its confluence with the Brisbane River in inner-Brisbane. Much of the creek’s lower reaches are contained within the Brisbane boundary, so the creek has played a significant role in Brisbane’s growth, which has resulted in it being one of its most urbanised and polluted waterways. Despite the considerable issues Oxley Creek faces, parts of the corridor still hold high ecological habitat and corridor values. Because of the above, and Brisbane City Council’s recognition of the potential of the Oxley Creek Corridor, Council established the Oxley Creek Transformation Pty Ltd to guide and deliver the long-term vision to create a master planned legacy for Brisbane. The master plan was underpinned by three main goals that drove planning and research. These goals were to be achieved through 12 strategies that articulated the approach, methods, plans and specific initiatives. They considered the catchment’s strategic context, capitalised on identified opportunities and responded to known issues. The goals and strategies were informed by local knowledge and ideas articulated during workshops with representatives from key community and environmental groups, technical studies, and a review of past studies, investigations, research, and similar projects. The goals and strategies were:

- **Goal 1 Environment** – Champion environmental protection, enhancement and resilience, inspire environmental conservation and demonstrate leadership in sustainability. Environmental strategies were:
  - Environmental Protection & Enhancement
  - Flood Preparedness and Resilience
  - Catchment, Waterway, and Water Management
  - Water Smart Planning and Design
- **Goal 2 Social/Community** – Capture social and community benefits by activating existing spaces and creating new places for people to gather, relax, play and connect with others and nature. Social strategies were:
  - Connecting Communities
  - Character, Identity and Interpretation
  - Diverse Experiences
  - Enterprising and Innovative Design and Governance
- **Goal 3 Economic** – Inspire sustainable economic uplift, establish partnerships and attract business interest and investment to fund activation and ongoing environmental revitalisation to boost the local economy. Economic strategies were:
  - Sustainable Economic Development
  - Financial Sustainability
  - Implementation and Place Management
  - Collaboration and Partnerships

This paper focuses on the Catchment, Waterway, and Water Management strategy under the Environmental Goal, including a summary of the environmental issues that were identified within the existing creek and catchment associated with this strategy, and the strategies that were proposed as part of the project to achieve the objectives of the master plan. This process drew on the existing knowledge of the researchers with regard to the catchment and the extensive body of work on Oxley Creek and its catchment characteristics and processes.

Oxley Creek Catchment and the Transformation Project Area

Oxley Creek is Brisbane's longest creek and flows over mostly sand-generating geology through much of its length. It flows from the granite uplands of Mount Perry in the Scenic Rim south of Ipswich, to its confluence with the Brisbane River at Tennyson, draining a catchment area of 260 km^2 (Figure 1). The catchment covers 35 suburbs and has five major tributaries. The catchment is split into the following parts:

- **Upper catchment:** straddles Ipswich and Logan City Councils and is densely vegetated.
- **Middle catchment:** located in Logan City Council and is a mix of low density residential development and dense vegetation. There is a small portion of the catchment which sits within the Flagstone Priority Development Area meaning high density development is planned.
- **Lower catchment:** located within Brisbane City Council and mostly developed with a mix of residential, rural residential, industrial, existing and historical sand mining operations, commercial, landfill, infrastructure (i.e. Archerfield Airport, Oxley Wastewater Treatment Plant), and open space landuses. These landuses have significantly impacted the geomorphology, hydrology, aquatic habitat quality, and water quality of the creek.

The Oxley Creek Transformation Project Area ('the corridor') is located within the lower catchment, extending from Johnson Road (on the Brisbane and Ipswich City Council boundary), and the Brisbane River (Figure 1). The corridor largely comprises open spaces within the Oxley Creek channel, and on its floodplain and terraces, with the corridor width dictated by the proximity of urban landuses.

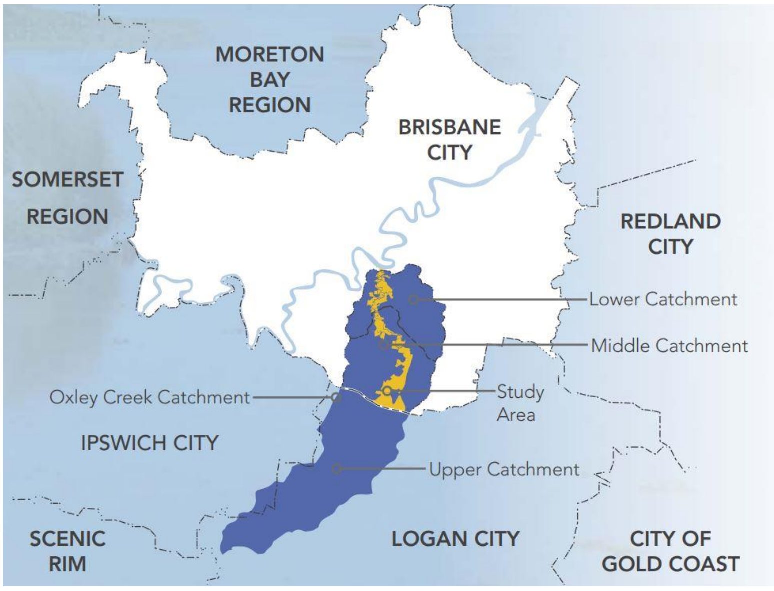

Figure 1 Location of Oxley Creek Catchment and the Oxley Creek Transformation Project Study Area ('the corridor') (Source: OCT (2018))

Catchment, Waterway, and Water Management – Existing Environment and Issues

Summary

The important catchment, waterway and water issues for Oxley Creek and the corridor are depicted in Figure 2. The following sections provide additional technical descriptions of the creek, catchment and issues.

Soils and Sediment

Soils across the corridor are podzolic soils, with sandy alluvial soils/sediment along the waterways (including sandy channel, terrace and floodplain material) and loamy soils on the elevated areas and upper terraces next to the waterways (Figure 3) (Blackman and Rutherfurd 2007, Hydrobiology 2005). Much of the soil in the elevated areas and terraces is highly dispersive. Any works occurring in the catchment or exposure of soils tends to result in erosion during wet conditions. The combination of lower sandy alluvial sediments and dispersive upper terraces represents a high risk for waterway erosion and it a primary reason why Oxley Creek has undergone and continues to experience widespread instream erosion.

The overall load of sediment discharged from the Oxley is relatively low, due to the densely vegetated middle and upper catchment, however, it is estimated that over 90% of the sediment load originates from stream erosion (Pietsch, et al. 2010).

Waterway

The creek has a complex history of disturbance that has resulted in significant impacts to channel integrity, water quality and habitat:

- Sand Extraction Ponds – The creation of large online and offline ponds as a result of historical sand extraction has instigated upstream channel deepening and widening but also acted as sediment sinks and limited downstream transport of sediment. The ponds and how they interact with the creek geomorphology represent a significant ongoing risk. City Projects Office (2011) suggested that impacts from extractive industry sites resulted in 40-50% of the sediment load from all sources and rehabilitation of these areas have the potential to reduce loads by 25-50%. Ponds are located throughout the corridor, with the major ones located at Holcim Ponds, Sergeant Dan Stiller Memorial Reserve (SDSMR), and a series of ponds referred to as Paradise Wetlands (Figure 2).
- Catchment Urbanisation and Disturbance – There has been a long history of disturbances that have occurred throughout the catchment, including vegetation clearance for agriculture, timber industries, large floods, urban expansion, and channelization (particularly of the estuary) (Blackman and

Rutherfurd 2007, Engeny & Hydrobiology 2014). These disturbances have increased sediment delivery, de-stabilised the channel, altered flow dynamics by increasing runoff volume, frequency, and peak discharges, destroyed or degraded habitat, and/or resulted in declines in water/sediment quality.

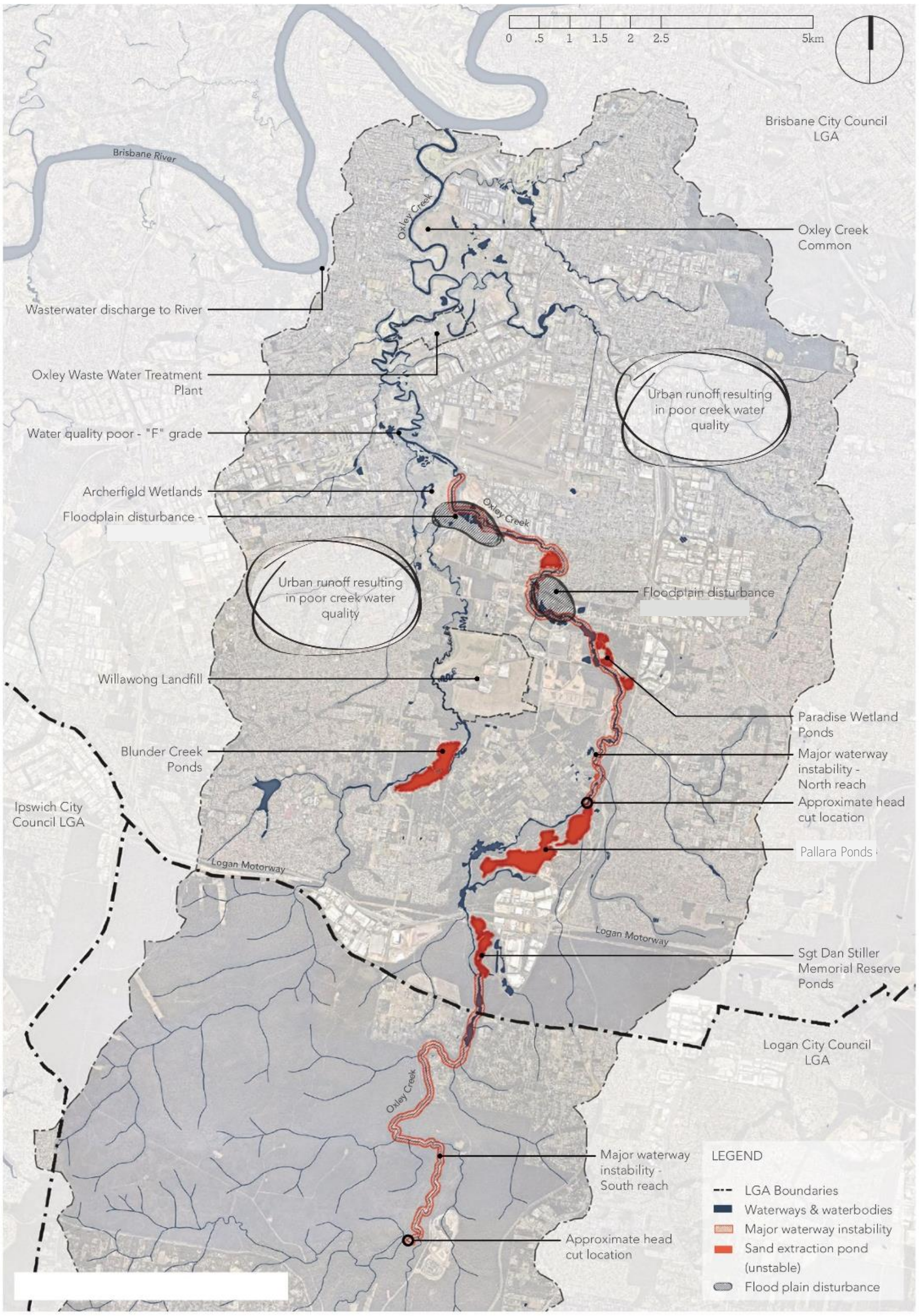

Figure 2 Oxley Creek Waterway Issues (Source: Lat27)

Figure 3 Photograph of the two main soil/sediment bodies

- Waterway erosion – There is a complex suite of processes that occur within the creek resulting in erosion. These include headcuts and their related impacts on channel incision and widening, stability of on-line and off-line pit lakes and channel adjustment in the estuary as a result of flood mitigation works (channel widening and dredging). Moderate isolated bank instabilities are present throughout the creek including the tidal reach, which will require stabilisation. Major channel erosion has and continues to occur at the following locations (Figure 2):
  1. North Reach – Substantial channel deepening and widening has occurred throughout much of this area (Figure 2), appearing to have been instigated by a headcut originating at the instream extraction at Paradise Wetlands (now inactive). The headcut has migrated upstream at least 3 km towards Pallara Ponds and will continue to migrate, as per the upstream headcut. Several unsuccessful attempts to arrest this migration have been made and the erosion has resulted in the loss of a major road bridge.
  2. South Reach - Substantial channel deepening and widening has occurred in this location appearing to have been instigated by a headcut originating near SDSMR. The headcut has migrated about 8 km upstream south into Logan City Council with the current head cut location shown on Figure 2. This headcut will continue to migrate upstream and mobilise sediment in the process, with much of the coarse sediment likely to be deposited within the Oxley Creek reaches and associated sand extraction ponds.
- Change in Creek Hydrology (because of future development) – Future development, particularly in the upper and middle catchment has the potential to change flows into the creek resulting in further waterway instability. Development within the lower catchment will not change the creek hydrology significantly (already mostly developed) but has the potential to have local hydrologic impacts.

Aquatic habitat

Within and adjacent to the corridor, landuse change and disturbance has resulted in modifications to aquatic habitat along Oxley Creek. Because of these modifications, aquatic habitat is in moderate to poor condition within the corridor. This rating is based on severely degraded riparian vegetation (including mangroves), displacement of riparian vegetation by invasive species (e.g. Brazilian peppertree), excessive growth of in-stream exotic plants (e.g. water hyacinth, salvinia), nutrient enrichment, pollutant inputs from the catchment, the presence of migration passage barriers (causeways, pit lakes, bed degradation), strong flows, siltation, and widespread channel erosion that have resulted from the disturbances listed above (BCC 2010, Hydrobiology 2005, McKenzie-Smith 2011).

Despite the poor conditions, there have been sightings of several native fauna, including platypus, two stream-dwelling frogs, a water rat, three turtle species, and 17 native fish species, although the distribution of these is not well known. This suggests that improved habitat opportunities would likely result in recovery of aquatic faunal assemblage health (Hydrobiology 2005).

There are several locations where aquatic habitat has been recognised as requiring protection, including Oxley Creek Common, Archerfield Wetlands and Blunder Creek, the anabranch adjacent to Pallara Ponds, and the reach adjacent to SDSMR. Further, there is recognition that pit lakes have the potential to provide aquatic habitat to a range of species, but little is known about the fauna/flora assemblages within these.

Water quality (surface/groundwater) and Stormwater Runoff

Water and sediment quality are generally considered as being poor throughout the waterway, with the estuarine reach generally receiving F gradings and the freshwater receiving only marginally improved gradings in the Ecosystem Health Monitoring Program (EHMP). This is largely attributed to the poor water quality associated with high nutrients, high turbidity, and low dissolved oxygen, with widespread exceedances of Oxley Creek Water Quality Objectives (City Projects Office 2011, Healthy Land and Water 2014). Water quality monitoring suggests that quality improves further upstream where the contribution of in-stream erosion and catchment urbanisation is less.

A range of pollutants indicative of the mix of historic and present land uses have been identified in water and sediment quality and biological investigations. These include nitrogen (ammonium, nitrates, nitrites) (Tsoi, Hadwen and Fellows 2011), phosphorous, dieldrin (Mortimer 2000), turbidity/Total Suspended Solids (TSS), metals (e.g. arsenic, chromium, vanadium) (Pietsch, et al. 2010), dissolved oxygen deficiencies (GHD 2010) and bacteria contamination. Contamination in the lower tidal reaches of the creek have rendered the creek unsafe for human contact at times. The source of pollutants includes the large areas of industrial and residential landuses in the lower catchment, historical unregulated landfilling and illegal dumping sites, closed landfill sites, naturally occurring acid sulphate soils and the ongoing waterway erosion in the creek. These landuses have contributed to contamination of both surface and groundwater. The project will need to consider the risk of groundwater interaction given the risk of contamination due to the level of interaction between groundwater, sand extraction ponds and Oxley Creek.

The water and sediment quality within the on-line and off-line pit lakes is largely unknown, with few studies having been undertaken. Contaminated water and sediments are likely to have accumulated over time, although the condition is likely to vary considerably between the pit lakes depending on their connection with the creek, flushing frequency, groundwater connection, aquatic and riparian habitat condition, and adjacent landuses. A snapshot water quality assessment of the waterbody at SDSMR suggested that there were few water and sediment quality parameters of concern for aquatic flora and fauna, or human recreational use (Chargulaf 2017). However, further works will be required to ascertain long term variability in water quality in this waterbody and others throughout the catchment.

Wastewater

The Oxley Wastewater Treatment Plant operated by Queensland Urban Utilities (QUU) is the second largest plant in Queensland and is located adjacent to the Logan Motorway. On average, the plant treats ~19.6GL of wastewater per year or 54ML/day. It has approval to discharge Class C wastewater to the Brisbane River at Corinda which includes 95 t/y of nitrogen and 40 t/y of phosphorus. The plant flooded in 2011 and a substantial upgrade to the plant has since occurred to improve performance and manage flood risk. The plant is located next to Oxley Creek Common and other large open floodplain areas. QUU are open to allowing water from the plant to be reused in the Oxley Creek Transformation Project.

Treated wastewater from the plant is used to supply Corinda Golf Course, internal water users within Council and QUU and tanker trucks during drought for construction purposes. The plant can also supply water to the Western Corridor Recycled Water Scheme pipeline located along Logan Motorway, however, the pipeline has not been used while water supply levels are night. Water authorities are reviewing the operation of Western Corridor Recycled Water Scheme.

Initiatives

The strategic approach regarding proposed rehabilitation, restoration, and stabilization initiatives drew on a combination of the four hydrogeomorphic approaches for urban stream protection and restoration proposed by Vietz et al. (2016). Namely, channel reconfiguration, flow regime management, floodplain space, and sediment management. In utilizing this guidance and to meet achieve the objectives of the Oxley Creek Transformation Project, several strategies were developed to address the catchment, waterway, and water management issues. Figure 4 presents the strategies spatially (where relevant) and summaries are provided below:

- Stabilise waterway (North Reach) – The progression of current head-cuts must be halted through bed control. Following this engineering and revegetation, work is required to limit channel deepening and widening in the already eroded locations. This will require a reach-wide approach that addresses the complex channel changes by adopting interventions that enhance natural processes, use soft-engineering approaches (e.g. log jams, riparian planting) where possible, and targeted engineered structures where appropriate that arrest the upstream migration of the headcuts and minimise risk of structure failure.
- Stabilise waterway (South Reach) – The progression of current head-cuts must be halted through bed control. Following this, engineering and revegetation work is required to limit channel deepening and widening in the already eroded locations, as per above.
- Stabilise and rehabilitate old sediment extraction ponds – The sand extraction ponds will need to be stabilised and revegetated. This may involve: stabilising the inflow/outflow points; establishing stable high flow bypass zones; reinforcing the bunds walls where required; filling in smaller ponds; lining edges of the ponds to minimise exposure of dispersive soils; revegetation through riparian and aquatic planting; introducing sustainable lake initiatives to improve water quality;
- Stabilise and rehabilitate the creek edges against various industrial sites – improvements to waterway buffer zones that fringe existing industrial sites will improve waterway form and water quality. Stabilisation of these areas is required which will involve sealing historical waste deposits, appropriate profiling of land and topsoil, revegetation and any engineering works to the waterway or ponds on the sites (as per above).
- General waterway stabilisation – identify all locations along the waterways which have instability issues (outside of the high priority locations above) and resolve stabilisation responses.
- Wetlands – rehabilitation of the existing waterbodies on the two main wetlands (Oxley Common, Archerfield) along with the creation of new wetlands strategically located to accept and treat stormwater runoff from the surrounding industrial landuses and catchments. Wetland design will need to carefully consider the existing water birds on the site and how they use the waterbodies. Opportunity also exists to harvest stormwater and reuse it to in locations such as Oxley Creek Common, to support revegetation efforts.
- Oxley Wastewater Treatment Plant wetland – Investigate a wastewater treatment wetland in proximity to the WWTP to take a portion of the discharge and treat. The treated water could be disinfected and used as a source of irrigation water across the Oxley Creek Transformation Project.
- Waterway buffers – waterway buffers and associated riparian plantings are required along each bank to allow for increased riparian vegetation density, improved riparian and aquatic habitat, improved habitat connectivity between Oxley Creek and neighbouring tributaries and high value vegetation areas, restrict movements on top of the creek banks, and improve bank stability.
- Ponds/lakes – several smaller ponds exist throughout the project. Although lower priority, these ponds will need stabilisation and revegetation to avoid future risks. These should be identified, and stabilisation designs developed.
- Stormwater management – explore opportunities to integrate stormwater treatment systems into open space areas of the project to capture urban runoff and treat or attenuate flows.
- Stormwater offset scheme – consider establishing an Oxley Creek stormwater offset scheme.
- Fish passage – fish passage should be preserved across any new in-stream barriers and should be

reinstated in older barriers, if any still exist.

- Groundwater – further investigation of groundwater conditions is required across the site to confirm groundwater levels, profiles and flow rates. The investigation can also assess the feasibility of using the groundwater system for stormwater aquifer storage and recovery.
- Development incentives – investigate development incentives in both Brisbane and to establish stormwater management objectives which provide enhanced protections to the receiving environment.
- Water monitoring – continued water and sediment quality investigations in the waterway (i.e. EHMP) and within the pit lakes to provide greater understanding of the type and location of impact sources and the areas where impacts are at their worst. Also commence annual inspection of the waterway geomorphology to gain an understanding of waterway stability and define high risk locations.
- Interact with recycled water schemes – investigate how the project can interact with recycled water schemes. This may involve supplying harvested stormwater to the pipeline or taking recycled water for irrigation.

Conclusions

In combination with improving environmental, social, community, and economic interactions, the Oxley Creek Transformation Project aims to be the catalyst for change regarding the health of the Oxley Creek corridor. The strategies have been developed to meet this aim through improving water quality, reducing bank erosion, improving in-stream habitat, improving ecological passage and connectivity, improving riparian corridor condition, protecting and enhancing remnant habitat, improving the quality of stormwater flowing into the creek, and reducing the volume and velocity of stormwater flowing into the creek.

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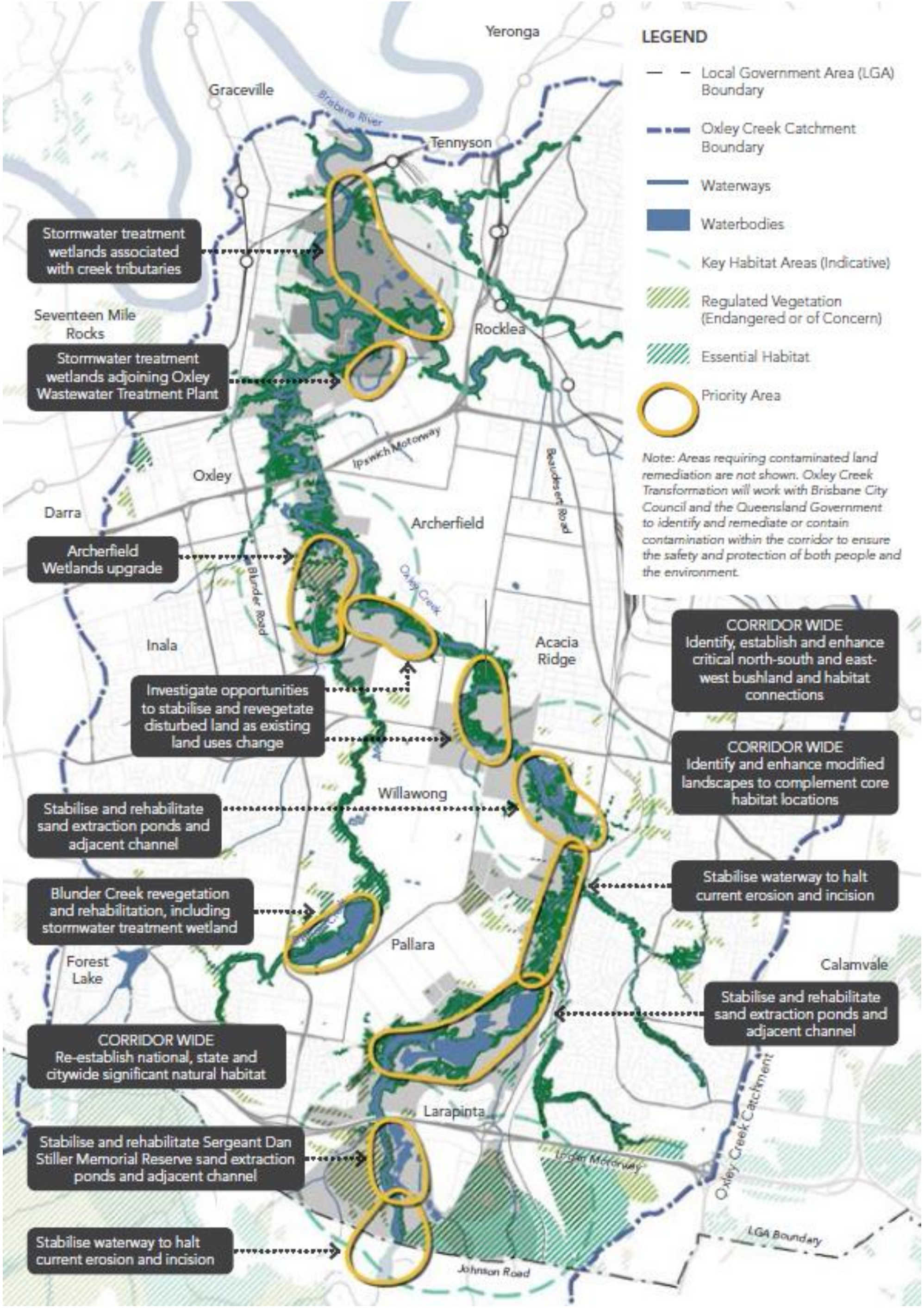

Figure 4 Waterway improvement strategies (Source: Lat27)

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