Government of **Western Australia**
Department of **Water**

Halls Creek Water Reserve

Drinking water source protection review

Halls Creek town water supply

Looking after all our water needs

Water resource protection series
Report WRP 123
January 2012

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Cover photograph: Aerial photograph of Halls Creek, GIS image by Yuot Alaak, using Landgate data.

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This publication is available at our website www.water.wa.gov.au or for those with special needs it can be made available in alternative formats such as audio, large print, or Braille.

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Summary

This drinking water source protection review considers changes that have occurred in and around the Halls Creek Water Reserve since completion of the 2002 *Halls Creek Water Reserve water source protection plan* (Water and Rivers Commission).

This 2012 review should be read in conjunction with the 2002 plan. Both of these documents are available on our website or by contacting us (see details on the inside cover of this report).

Halls Creek is located 300 km south of Kununurra in the Kimberley region. It is a busy service town for surrounding pastoralists, Aboriginal communities, travellers and extractive industries (such as nickel, platinum and diamond mines).

The Halls Creek town water supply is obtained from a Water Corporation wellfields in fractured rock aquifers, which are vulnerable to contamination from overlying land uses. Given this contamination risk, considered management of land use and development in the Halls Creek Water Reserve is necessary to protect water quality and to help protect public health.

The 2002 plan identified eight production bores in the wellfield. Since 2002, a number of those bores have been decommissioned and other bores have been developed. In 2011 there were 14 production bores (not all in use).

In recent years, Water Corporation completed an extensive aerial geophysics mapping and drilling program in response to the growing demand for water in Halls Creek. Seven locations for new production bores were identified (additional to the 14 existing bores) to help meet the Shire's ongoing development needs. These bores are currently under construction in the priority 1 (P1) area of the water reserve. New bores (see Figure 2) will require new wellhead protection zones (WHPZ). The water supply demand for Halls Creek is growing and water source protection processes will need to be ready to respond to future changes.

The major part of the area covered by the Halls Creek Water Reserve is either unallocated crown land, crown reserves or crown leases, and is largely undeveloped. Where the Shire of Halls Creek town planning scheme no. 1 overlaps the Halls Creek Water Reserve (see Figure 4) it lists the zoning as: rural/pastoral, local authority reserves, and a smaller portion of special rural.

Crown land pastoral grazing activities are a major land use in most of the water reserve's recharge area. These non-intensive activities are not considered to pose a significant risk to water quality if managed appropriately.

Since 2002, the only water quality contamination risk that may result in a change to the existing water reserve is within the P1 area of Burks Park Station. In the vicinity surrounding the homestead, some development has occurred that may need to be recognised by applying a priority 3 (P3) area to it. The Department of Water will discuss this option with the station and the Department of Housing. Moreover, the development of seven new bores within the P1 area, along with their protection zones, will now need to be reflected in this water reserve.

Key information about the Halls Creek Water Reserve (2012):

Halls Creek Water Reserve (2012)	
Local government authority	Shire of Halls Creek
Locations supplied	Halls Creek
Aquifer type	Fractured rock (therefore vulnerable to surface contamination)
Licensed to abstract	700 000 kL/year (2010/11)
Number of bores	14 production bores (not all in use) and seven under construction (see Figure 3).
Dates of bore completion	1989 to present - ongoing
Date of drinking water source protection report	1. 2002 *Halls Creek Water Reserve water source protection plan* 2. *2012 Halls Creek Water Reserve drinking water source protection review*
Proclamation status	Proclaimed in 2004 under the *Country Areas Water Supply Act 1947*, as *Halls Creek Water Reserve*. No changes to the existing boundary are required.

1 Review of Halls Creek's drinking water source protection plan

1.1 Water reserve boundary, priority areas and protection zones

The existing Halls Creek Water Reserve was proclaimed in 2004 under the *Country Areas Water Supply Act 1947* following completion of the *Halls Creek Water Reserve water source protection plan* (Water and Rivers Commission 2002). This drinking water source protection review considers changes that have occurred in and around the Halls Creek Water Reserve since completion of that 2002 plan.

This 2012 review must be read in conjunction with the 2002 plan. Both of these documents are available on our website or by contacting us.

Halls Creek is located 300 km south of Kununurra in the Kimberley region. It is a busy service town for surrounding pastoralists, Aboriginal communities, travellers and extractive industries (such as nickel, platinum and diamond mines).

The Halls Creek town water supply is obtained from Water Corporation wellfields in two fractured rock aquifers, the King Leopold Sandstone and the Carson Volcanics (Department of Water 2006 and Water Corporation 2004).

Fractured rock aquifers are vulnerable to contamination from overlying land uses. Therefore, management of land use and development in the Halls Creek Water Reserve is necessary to protect water quality and to help protect public health. See Appendix C for an overview of how public drinking water source areas are protected in Western Australia.

No changes to the existing water reserve boundary are proposed in this review but the addition of new bores (see Figure 2) will require new wellhead protection zones (WHPZ).

It should be noted that subject to further consultation, a priority 3 (P3) area may be assigned around the Burks Park Station homestead to reflect some existing buildings and proposed new wastewater infrastructure near the homestead.

If you require more information on the background to and support for protection of public drinking water source areas (PDWSAs), please refer to our water quality protection note (WQPN) no. 36: *Protecting public drinking water source areas*.

1.2 Update on existing water supply scheme

The 2002 plan reported eight active production bores. Since 2002, a number of those bores have been decommissioned and some additional bores have been developed.

In recent years, Water Corporation completed an extensive aerial geophysics mapping and drilling program in response to the growing demand for water in Halls Creek. In 2011 there were 14 production bores (not all in use at the time of this

publication), and seven new bores are being constructed in the priority 1 (P1) area (see Figure 2). Some of the existing bores may become decommissioned or be put on standby if the new bores are successful. New bores (see Figure 2) will require new wellhead protection zones (WHPZ).

Raw water is chlorinated prior to blending in a collector tank, it is then treated with calgon (when necessary) prior to storage in a 2500m^3 service tank and distribution.

The Water Corporation's current groundwater allocation licence is to draw 700 000 kL annually.

1.3 Aboriginal sites of significance and Native Title claims

Aboriginal sites of significance are areas that Aboriginal people value as important and significant to their cultural heritage. The sites are significant because they link Aboriginal culture and tradition to place, land and people over time. These areas form an integral part of Aboriginal identity and the heritage of Western Australia. The *Aboriginal Heritage Act 1972* (WA) protects all Aboriginal sites in the state. There are several Aboriginal sites of significance in the existing Halls Creek Water Reserve. Sites of significance named *Halls Creek* (K00755 and K01250) overlaps a portion of the P1, Priority 2 (P2) and P3 areas (and also contain an Aboriginal community, called the Nicholson Bloc/Camp, in the P3 area). Permanent sites of significance *Halls Creek East 1 to 5* occur in the P1 area. The custodian of the Aboriginal sites dataset and the appropriate contact organisation for information is the Department of Indigenous Affairs.

Native Title is the recognition in Australian law that some Aboriginal people continue to hold Native Title rights to lands and water arising from their traditional laws and customs. There are Native Title claims in the Halls Creek Water Reserve area; an updated register of claims for the area should be consulted at the National Native Title Tribunal.

The Department of Water is committed to working with Aboriginal people in its planning and management activities. The department recognises that Native Title provides an important framework for water management.

1.4 Water quality information

The Water Corporation has provided updated water quality information for the Halls Creek bore field. This is shown in Appendix B.

1.5 Update on water quality risks

As part of this review we have completed an assessment of water quality contamination risks to the Halls Creek Water Reserve. Current land uses and activities and their risks to the drinking water source are described below and in the assessment of the risks to water quality in Table 1 at the end of this section.

The groundwater resource used for public water supply occurs within the Carson Volcanics and King Leopold Sandstone along clearly defined ridges extending north-east from Duncan Highway to beyond the Elvire River (see Figure 3). Fractured rock aquifers are vulnerable to contamination.

The King Leopold Sandstone aquifer has a relatively small storage capacity. As a result, under the influence of pumping, contaminants can move quickly along the joints and fractures towards the Water Corporation's production bores. The aquifer is less vulnerable to contamination from adjoining features as groundwater flow from adjacent geological formations is limited.

Most of the land covered by the current water reserve is listed as unallocated crown land, crown reserves and crown leases (see Figure 1).

A large portion of the water reserve is undeveloped (Figure 3), and contains portions of crown leases for pastoral purposes (e.g. Burks Park Station).

According to the current Halls Creek town planning scheme (TPS) no. 1, most of the production bores are sited in lots with rural/pastoral zoning, or outside the zoning of the TPS (see Figure 4). Rural/pastoral zoning has the objective of maintaining the existing rural character.

The Halls Creek wastewater treatment plant is located on the Duncan Highway (see Figure 3). The system covers an approximate area of 27.5 ha and consists of primary and secondary clay lined ponds, with treated effluent being discharged into an evaporation pond (Figures D3 and D4). This wastewater treatment plant overlaps the WHPZs of bores 7/90, 2/89 and 4/92, and is a pre-existing land use in the P1 area (Figure 2). During high rainfall events (i.e. one in ten years) these clay-lined ponds can overflow and discharge to a creek that flows away from the production bores to China Wall Pool south of the Halls Creek Water Reserve. A ridge line separates the wastewater treatment plant from the production bores.

The Department of Agriculture and Food has a cattle dip tank and a stock truck wash down/quarantining facility in the general vicinity of the wellfield, on Duncan Highway (Figures D5 and D6). A road train assembly and fuel storage area is located in the P3 area on Great Northern Highway. (See Figure 1.)

Sites in the water reserve have been reported as known or suspected contaminated sites under the *Contaminated Sites Act 2003*, which is administered by the Department of Environment and Conservation (DEC). Hydrocarbons from pipeline leaks and storage tanks are the main forms of contamination. Any site that DEC has classified as requiring remediation should be addressed as soon as possible to reduce the risk of groundwater contamination (DEC's updated register at the Contaminated Sites Database should be consulted).

Residential and industrial zoned areas of Halls Creek occur within the Halls Creek Water Reserve (Figure 4). A significant portion of the town is owned or managed by government. Approximately 40 per cent of dwellings (ABS census data 2006) are classed as 'other dwellings', which includes improvised homes, tents, caravans and cabins (Syrinx Environmental Pty Ltd 2010).

There is also a special rural zoned area (with the objective of retaining the predominant rural/residential character) within the P2 area of the water reserve – the McBeath Estate south of Duncan Highway. WHPZs of bores 3/92 and 1/93 overlap with this special rural area.

Rural-residential lots in the McBeath Estate vary from 0.5 to 2.2 ha, and have crown land titles with leasehold rights for limited terms (local planning strategy of the Western Australia Planning Commission 2006b). A number of non-rural uses have been established in this area, including semi-industrial operations such as a concrete batching plant.

Failing septics have been reported in some McBeath lots. In the Nicholson Block/Camp Aboriginal community (see Figure 1) effluent from on-lot septics goes to a central common collector and then by sewer to the town system (Syrinx Environmental Pty Ltd 2010).

Table 1 Land use and potential water quality risks

* For brevity's sake the water quality protection notes (WQPN) and water quality protection guidelines (WQP) are listed only by number in this table. Full details are provided in the References list.

WQPN no. 25 would be relevant to all the land uses discussed below.

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance *
Water treatment				
Wastewater treatment plant.	Pathogens and nutrients from overflow. Spills/leaks of treatment chemicals.	High	The Halls Creek wastewater treatment plant is located in the P1 area. The wastewater treatment plant has clay lined ponds and treated water is evaporated. DEC licences this waste treatment facility under the *Environmental Protection Act 1986.*	Water Corporation operating procedures and groundwater monitoring. WQPN nos 26, 27 and 39.
Industrial use, workshops and fuel storage areas				
Fuel/oil leaks or spills. Other chemical leaks or spills.	Hydrocar-bons and other chemicals.	Medium	The 2006 local planning strategy indicated a large part of the Halls Creek Water Reserve not being within the electricity licence area, and therefore fuel storage is required for electricity generation. Fuel depots are regarded as incompatible in P1 areas but compatible with conditions in P3 areas. In P3 areas, motor vehicle wash and repairs are seen as compatible with conditions. Within P1 and P2 areas, several industries such as concrete batching, and cement product manufacture, as well as routine servicing and wash-down of operating equipment, are incompatible. The Halls Creek industrial-zoned area is in the P3 area. Several industrial pursuits are regarded as compatible with conditions in P3 areas (see WQPN no. 25)	WQPN nos 7, 10, 20, 28, 49, 51, 52, 53, 56, 58, 60, 61, 62, 65 and 93.
Servicing and repair of vehicles and machinery (farm, industrial, depots, etc.).	Hydrocar-bons and chemicals from vehicle maintenance and use.	Medium	A diesel spill at the Shire depot (on the Duncan Highway, P3 area) led to the site being listed as a known or suspected contaminated site under the *Contaminated Sites Act* 2003. This spill has been cleaned up. Service stations (this includes service stations at transport and municipal works depots and automotive repairs) are incompatible in P1 and P2 areas and compatible with conditions in P3 areas.	WQPN nos 28 and 68.

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance *
Extensive agricultural land uses: rural & special rural zoned areas; pastoral				
Rural living, in areas zoned special rural and rural.	Pathogens and nutrients from septic tanks, domestic animals and fertilisers. Nutrients from fertilisers. Pesticides and other chemicals stored, used and disposed. Hydrocar-bons from roads/tracks, fuel storage, vehicle mainte-nance.	Medium	Extensive (i.e. non-intensive) agricultural pursuits are compatible with conditions in P2 areas. Crown reserve 38453 (a portion of the northern P3 area) is vested with the education department (Teaching WA) for the purpose of keeping horses (see Figure 1).	WQPN nos 1, 6, 9, 12, 17, 22, 25, 32, 33, 41, 48, 65, 80, 98, 70, 88, 96, 101 and 104. Public sector circular (PSC) no. 2: Pesticide *use in public drinking water source areas.* PSC no. 88: *Use of herbicides in water catchment areas.* Department of Agriculture's *Stocking rate guidelines for small rural holdings*.
Pastoral leases (stock grazing and broad hectare	Contamina-tion from pesticide and herbicide	Low°	Compatible with conditions in P1 areas, special conditions may be recommended in WHPZ. Acceptable in P2 and P3 areas. Extensive agricultural pursuits are compatible with conditions in P2 areas. Halls Creek agriculture predominantly relies on live cattle export.	WQPN no. 35.

Land use/activity	Hazard	Management priority	Comments	Best management practice guidance *
cropping). Food gardening.	use. Nutrients from fertiliser use and stock. Pathogens from stock, humans			
° In the event of intensification of land use on pastoral stations, the management priority of these land uses and activities should be reviewed to ensure water quality protection measures are considered.				
Residential zoned land				
Domestic animals, people on unsewered lots. Fertiliser application. Pesticides and household chemicals. Fuel/oil leaks or spills.	Pathogens Nutrients Hydrocar-bons and other chemicals.	Medium	Portion of the town is in P3 area - the majority of urban lots are connected to sewer.	WQPN nos 25, 48, 70.

Quarantine control, dipping and truck wash down facilities				
Quarantine control, dipping and truck wash down facilities.	Pathogens Pesticides Hydrocar-bons and other chemicals.	Medium/ High	Department of Agriculture and Food facilities in P1 area on Duncan Highway. There also is a truck wash down site on the Great Northern Highway in P3 area.	WQPN nos 47, 56, 58, 61, 62, 65 and 68. Statewide policy PSC 2: *Pesticide use in PDWSA.*
Private and Water Corporation's bores				
Bores	Pathogens, nutrients, hydrocar-bons and other chemicals such as pesticides.	Medium/ High	The 2006 local planning strategy indicated a large part of the Halls Creek Water Reserve is not located within the potable services area. Bores drilled near a public drinking water supply bore (e.g. for irrigation or private purposes) can cause contamination of the drinking water source. For example, a poorly constructed/ maintained bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer. It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through the Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914* (WA). New bores require a licence from the Department of Water for anything other than domestic use. Public drinking water supply bores are in secure Water Corporation compounds, with signage (see Figures D1 and D2), most are electrified.	All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003). WQPN no. 30. If bores use fuel: WQPN nos 56, 58, 61 and 62. PSC no. 88: *Use of herbicides in water catchment areas.*

Mining operations				
Fuel/oil/other chemicals leaks and spills. Human activity.	Hydrocar-bons and other chemicals. Turbidity Pathogens from human activity.	Low	Compatible with conditions in P1, P2 and P3 areas. Gravel mining occurs in the P3 area along the Great Northern Highway. There are mining tenements over the whole of the water reserve. Copper, lead, zinc, gravel and gold are also mined close to the water reserve.	WQPN nos 15, 56, 58, 60, 61, 62, 64 and 65. WQP *Water quality management in mining and mineral processing* nos 1 to 11. *Policy and guidelines for construction and silica sand mining in public drinking water source areas* (Water and Rivers Commission 1999).
Recreational activities				
Horse riding, race track rodeo grounds, and stables.	Pathogens from human and horse waste. Soil compaction and turbidity from erosion.	Medium	Stables and equestrian centres are ‘compatible with conditions’ in P3 areas. There is a riding school adjacent to bore 3/70.	WQP Statewide Policy no. 13: *Policy and guidelines for recreation within public drinking water source areas on Crown land*. WQPN nos 67, 82 and 81. With regard to keeping of animals, see rural and special rural land use above.

Roads and tracks				
The Duncan Highway traverses the water reserve; the Great Northern Highway is on western border of water reserve.	Hydrocarbon and other chemical contamination from fuel and spills.	Low	Existing sealed roads are acceptable within the water reserve.	WQPN no. 44. PSC no. 88, Statewide Policy 2: *Pesticide use in PDWSA.*

2 Implementation of Halls Creek's 2002 water source protection plan

2.1 Status of previous recommendations

Table 2

This table reflects the current (2012) status of recommendations from the 2002 plan.

No.	Description in 2002 plan	Status	Comments
1	The Halls Creek Water Reserve boundary should be amended as shown in Figure 5.	Completed	Gazetted in 2004 under the *Country Areas Water Supply Act 1947* (WA).
2	The town planning scheme should recognise the *Halls Creek Water Reserve water source protection plan* and support land uses compatible with the priority classifications. Also, planning strategies should incorporate the management principles outlined in the Water and Rivers Commission's *Land use compatibility within public drinking water source areas* and reflect the priority classifications given to the water reserve.	Completed	The *Shire of Halls Creek TPS No 1* (updated to 2/2/10) does not recognise the Halls Creek Water Reserve as a special control area. However the 2006 *Halls Creek Horizons local planning strategy* (as updated 29/08/07) does refer to the 2002 *Halls Creek Water Reserve water source protection plan,* the various priority areas (P1, P2, P3) in the water reserve and the need for appropriate land use and development. The need to reflect the Halls Creek Water Reserve as a special control area in the Shire of Halls Creek TPS will be carried forward into the 2012 updated recommendations.
3	Development proposals in the water reserve that are likely to impact on water quality should be referred to the Water and Rivers Commission.	Completed	Guidelines have been provided through the Department of Water's water quality protection note series. Development proposals are referred to the Kimberley Region office of the Department of Water. The need to refer development proposals will be carried forward into the 2012 updated recommendations.

4	Signs should be erected along the boundaries of the water reserve to define the reserve and promote public awareness of the need to protect water quality.	Completed	Signs advising on the location of the water reserve have been erected. Water Corporation signs are also displayed on bore compound fences (some bores are still under development).
5	Incidents covered by WESTPLAN – HAZMAT in the Halls Creek Water Reserve should be addressed through the following measures: • The Halls Creek local emergency management advisory committee (through the Broome emergency management district) being familiar with the location and purpose of the Halls Creek Water Reserve. • The locality plan for the Halls Creek Water Reserve being provided to the Fire and Rescue Services headquarters for the HAZMAT emergency advisory team during incidents in the Halls Creek Water Reserve. • The Water and Rivers Commission advising the HAZMAT emergency advisory team during incidents in the Halls Creek Water Reserve. • Personnel dealing with WESTPLAN–HAZMAT incidents in the area are given ready access to a locality map of the water reserve and training to understand the potential impacts of spills on the groundwater source.	Completed	Emergency response protocols have since changed to the jurisdiction of HAZMAT and the local emergency management committee. A recommendation to reflect this change will be made in the 2012 updated recommendations.
6	A surveillance program should be established to identify any incompatible land uses or potential contaminant threats within the Halls Creek Water Reserve, especially within the special rural area.	Completed	Water Corporation undertakes surveillance within the water reserve. This will continue to be a 2012 recommendation. Halls Creek Water Reserve is not currently delegated to the Water Corporation. A recommendation to delegate this source will be made in the 2012 updated recommendations.

7	Review monitoring program.	Completed	Water Corporation undertakes water quality monitoring within the water reserve in accordance with the *Australian drinking water guidelines* and interpretations agreed to with the Department of Health. This will continue to be a 2012 recommendation.
8	Monitoring of groundwater quality at the Halls Creek wastewater treatment plant should continue as required by the Department of Environmental Protection's licence.	Completed	This recommendation is addressed by DEC/ Environmental Protection Act 1986 licence. The Department of Water will liaise with DEC and Water Corporation on the operation and protection of water quality of this site.
9	The operation and management of the Agriculture Western Australia stock handling facility should be reviewed to ensure water quality protection objectives are being met.	Completed	On inspection in 2010, this facility appeared to be infrequently used. The Department of Water should seek advice from Departure of Agriculture and Food on its future use. This will continue to be a 2012 recommendation.
10	Bunding and security of fuel storage and transfer systems at bores E and 1/76 should be upgraded.	Completed	Bore E has since been decommissioned, and its replacement, bore 3/06 is electrically powered.
11	Review of the plan and recommendations.	Completed	Undertaken through the preparation of this 2012 review document. Recommend replacing the 2002 plan and this 2012 review with a new plan within five years.

2.2 Consolidated recommendations

Based on the findings of this review the following recommendations will be applied to the Halls Creek Water Reserve. The stakeholders mentioned in brackets are expected to have a responsibility for, or an interest in the relevant recommendation being implemented.

1 Incorporate the 2002 plan and this 2012 review into the *Shire of Halls Creek local planning scheme* in accordance with the WAPC's Statement of planning policy no. 2.7: *Public drinking water source policy;* and section 6.2 of the Town planning strategy which identifies amendments required to the TPS, to progress that strategy. Include the Halls Creek Water Reserve as a special control area in the local planning scheme and reflect the Halls Creek Water Reserve boundary, priority areas (P1, P2 and P3) and WHPZ (see Figure 2). (Shire of Halls Creek)

2 All development proposals within the Halls Creek Water Reserve that are inconsistent with the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas,* or recommendations in the 2002 plan or this 2012 review, should be referred to the Department of Water for advice and recommendations. (Department of Planning, Shire of Halls Creek, proponents of proposals)

3 Incidents covered by WESTPLAN–HAZMAT (Western Australian plan for hazardous materials) in the Halls Creek Water Reserve should be addressed by ensuring that:

- the Halls Creek local emergency management committee (LEMC) is aware of the location and purpose of the Halls Creek Water Reserve
- the locality plan for the Halls Creek Water Reserve is provided to the FESA headquarters for the HAZMAT emergency advisory team
- the Water Corporation acts in an advisory role during incidents in the Halls Creek Water Reserve
- Personnel who deal with WESTPLAN–HAZMAT incidents within the area should have access to a map of the Halls Creek Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this drinking water source. (Department of Water and Water Corporation)

4 The operation and management of the Shire of Halls Creek's storage depot should be reviewed to ensure water quality protection objectives are being met, including bunding for the oil storage facility. (Department of Water and Shire of Halls Creek)

5 The Department of Water should seek advice from Department of Agriculture and Food on its future use of the quarantining facility with cattle dip tanks and a stock truck wash down. (Department of Water)

6 This plan recommends that surveillance and by-law enforcement for the Halls Creek Water Reserve be formally delegated to the Water Corporation. (Department of Water and Water Corporation)

7 Water Corporation undertakes surveillance within the water reserve. (Water Corporation)

8 The Department of Water liaises with DEC and Water Corporation on the operation and protection of water quality at the Halls Creek wastewater treatment plant. (Department of Water, Water Corporation and DEC)

9 This 2012 review and the 2002 *Halls Creek Water Reserve water source protection plan* should be replaced with a new, combined drinking water source protection plan before 2016. (Department of Water)

Appendices

Appendix A — Figures

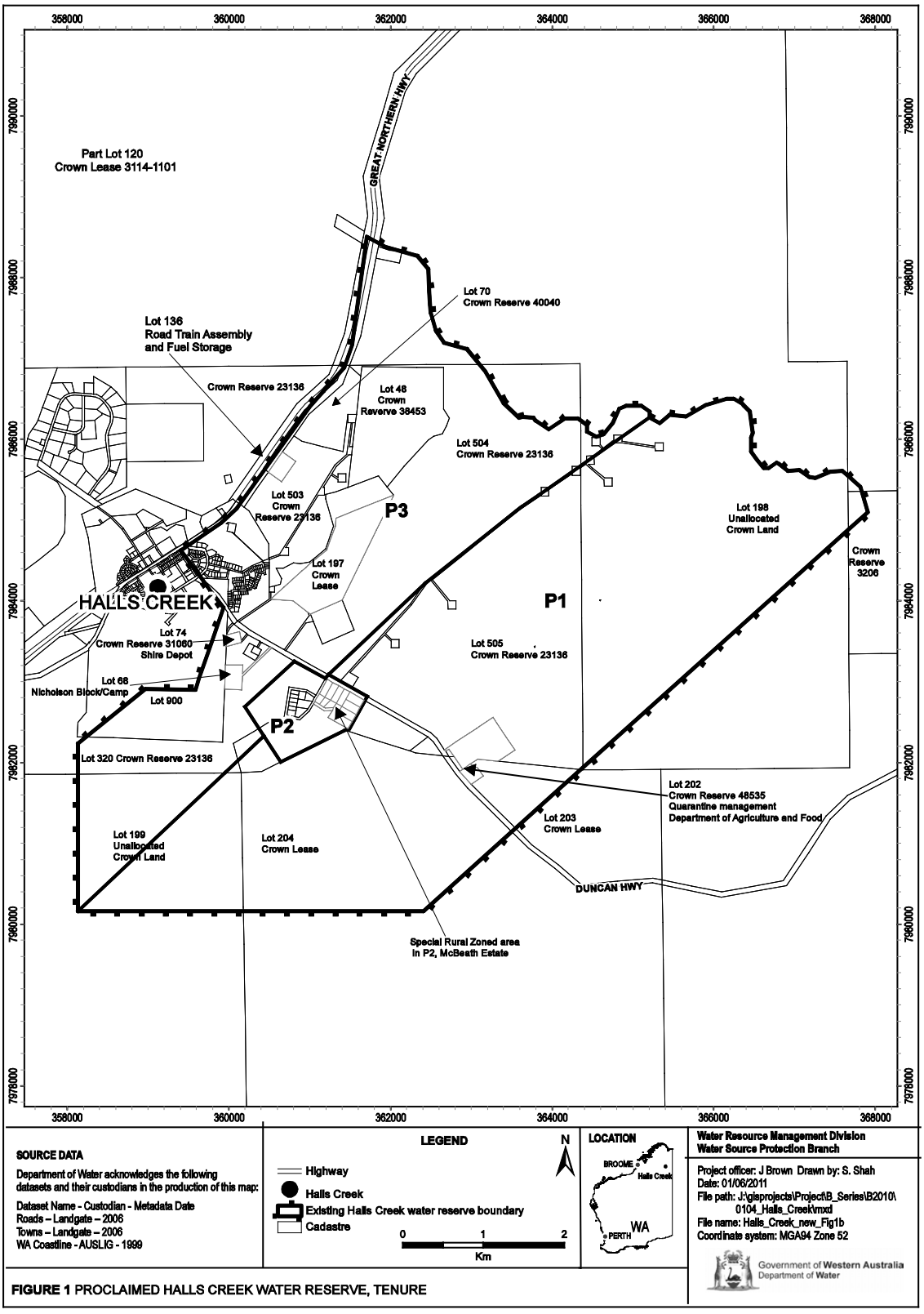

FIGURE 1 PROCLAIMED HALLS CREEK WATER RESERVE, TENURE

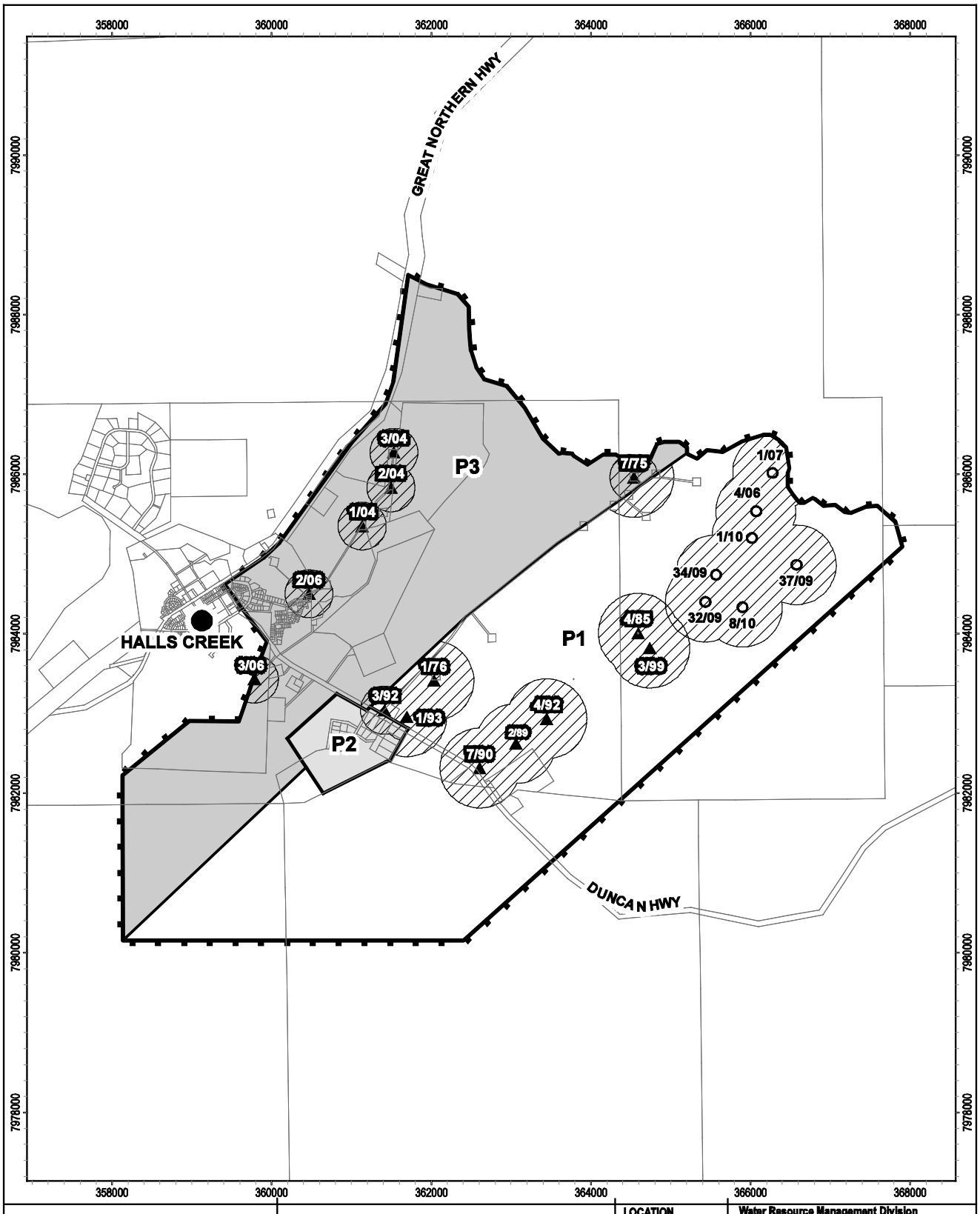

FIGURE 2 BORES CURRENTLY IN PRODUCTION OR UNDER CONSTRUCTION IN THE HALLS CREEK WATER RESERVE, THEIR WELLHEAD PROTECTION ZONES AND THE PRIORITY AREAS.

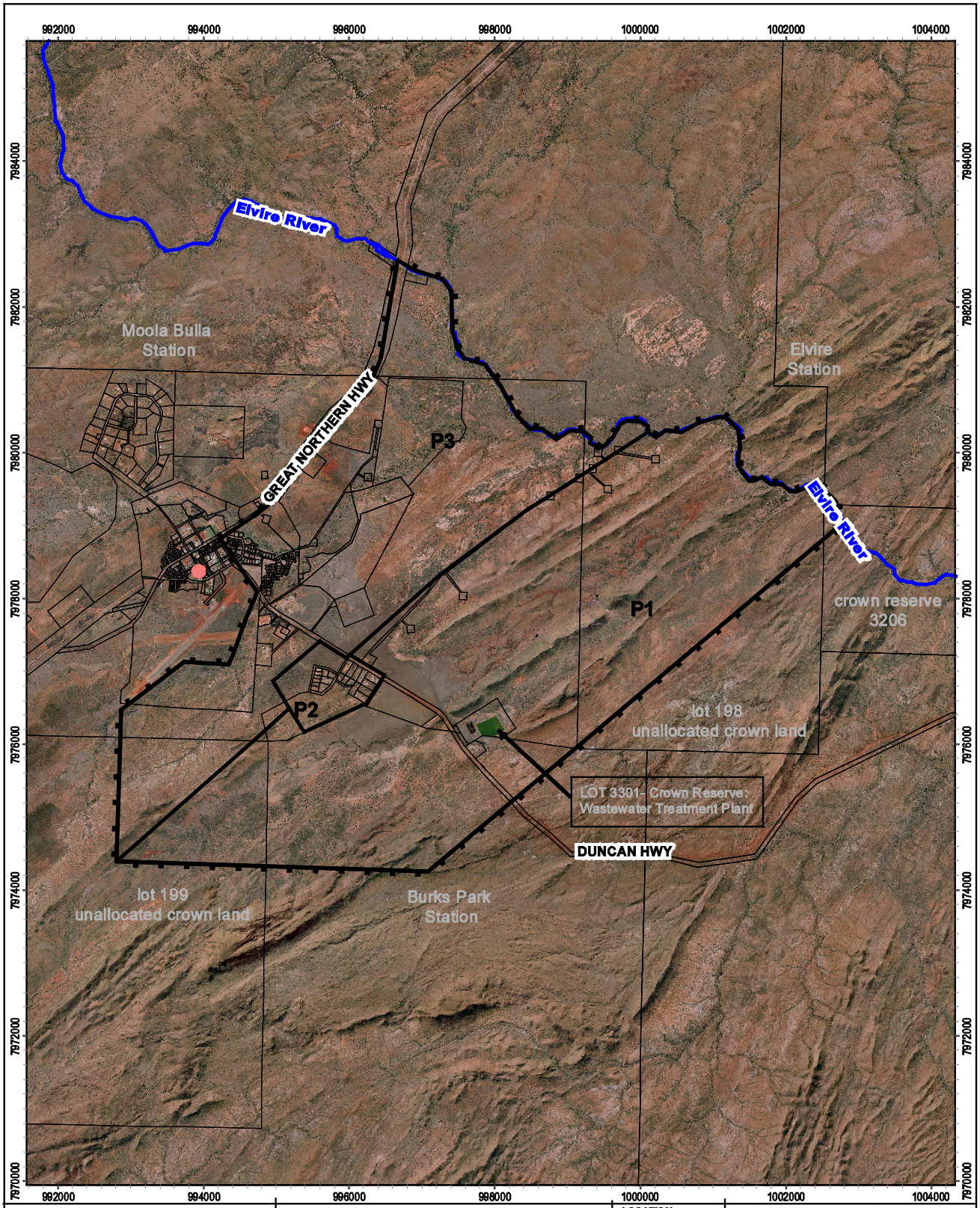

FIGURE 3 EXISTING HALLS CREEK WATER RESERVE: AERIAL PHOTO SHOWING NON-INTENSIVE LAND USE

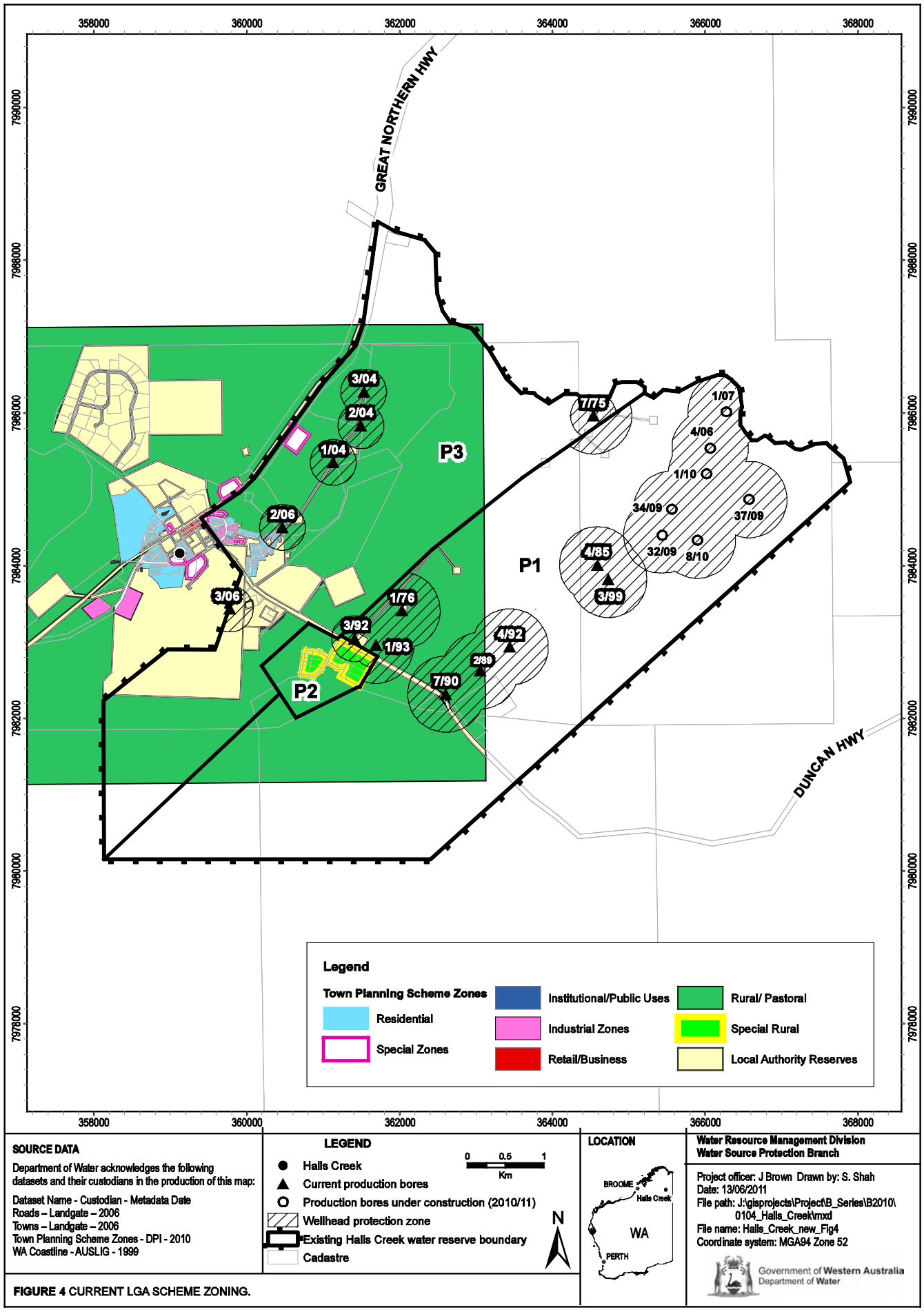

FIGURE 4 CURRENT LGA SCHEME ZONING.

Appendix B— Water quality data

The information provided in this appendix has been prepared by the Water Corporation.

The Water Corporation has monitored the raw (source) water quality from Halls Creek bore field. The data show the quality of water in the catchment.

An assessment of the drinking water quality is also made in accordance with the *National water quality management strategy: Australian drinking water guidelines 6*, 2004 (ADWG) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including
  - health-related chemicals
  - microbiological contaminants.

The following data represent the quality of raw water from Halls Creek bore field. In the absence of specific guidelines for raw-water quality, the results have been compared with the ADWG values set for drinking water, which define the quality requirements at the customer's tap. Results that exceed the ADWG are in bold and italics to give an indication of potential raw-water quality issues associated with this source.

It is important to appreciate that the raw-water data presented do not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG. The values are taken from ongoing monitoring during February 2006 to January 2011.

For more information on the quality of drinking water supplied to Halls Creek, refer to the most recent Water Corporation drinking water quality annual report available at their website www.watercorporation.com.au> What we do > Water quality > Water quality publications > Most recent *Water quality annual report*.

Aesthetic

The aesthetic quality analyses for raw water from Halls Creek bore field are summarised in the following table:

Aesthetic detections for Halls Creek bore field

Parameter	**Units**	**ADWG aesthetic guideline value***	**SP Halls Creek electric bore field (raw)**		**SP Halls Creek OLD bore field (raw)**	
			Range	**Median**	**Range**	**Median**
Chloride^	mg/L	250	150 - 150	150	43 - 50	45
Colour – True	TCU	15	<1 - 3	<1	<1 - 2	<1
Hardness as CaCO3	mg/L	200	***320 - 326***	***323***	150 - 160	150
Iron unfiltered	mg/L	0.3	<0.003 – 0.22	<0.003	<0.003 – 0.014	<0.003
Sodium	mg/L	180	150 - 155	152.5	62 - 71	70
Total filterable solids by summation^	mg/L	500	***998 - 998***	***998***	***540 - 551***	***544***
Turbidity	NTU	5	<0.1 - ***10***	<0.1	<0.1 – 0.2	<0.1
pH measured in laboratory	No unit	6.5 – 8.5	7.05 – 7.74	7.23	6.98 – 7.54	7.21
Zinc	mg/L	3	-	-	0.02 – 0.02	0.02

Health related

Health-related chemicals

Raw water from Halls Creek bore field is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that impact on water quality are summarised in the following table. No parameters exceeded the ADWG health guideline values.

Health-related detections for Halls Creek bore field

Parameter	Units	ADWG health guideline value*	SP Halls Creek electric bore field (raw)		SP Halls Creek OLD bore field (raw)	
			Range	Median	Range	Median
Barium	mg/L	0.7	-	-	0.24 – 0.26	0.25
Boron	mg/L	4	-	-	0.1 - 0.12	0.11
Copper	mg/L	2	-	-	0.008 – 0.02	0.014
Fluoride laboratory measurement	mg/L	1.5	0.45 – 0.55	0.5	0.6 – 0.9	0.75
Manganese unfiltered	mg/L	0.5	<0.002 – 0.004	<0.002	-	-
Nitrate as nitrogen	mg/L	11.29	0.21 – 1.6	0.915	-	-
Nitrite as nitrogen	mg/L	0.91	<0.002 – 0.005	<0.002	-	-
Nitrite plus nitrate as N	mg/L	11.29	0.62 – 1.6	1.1	1.4 – 1.9	1.7
Radon - 222^	Bq/L	100	-	-	24.9 – 24.9	24.9
Sulphate	mg/L	500	53 - 56	54.5	17 - 20	17
Uranium	mg/L	0.02	-	-	0.007 – 0.013	0.009

* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHRMC & ARMCANZ, 2004a).

† The guideline value of 11.29 mg/L Nitrite plus Nitrate (as nitrogen) and Nitrate (as nitrogen) has been set to protect bottlefed infants under three months of age. Up to 22.58 mg/L (as nitrogen) can be safely consumed by adults and children over three months of age.

^ Based on one sample.

Microbiological Contaminants

Microbiological testing of raw water samples from Halls Creek bore field is currently conducted on a monthly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water.

A detection of *Escherichia coli* in raw water abstracted from any bore may indicate contamination of faecal material through ingress in the bore, or recharge through to the aquifer (depending on aquifer type).

During the review period of February 2006 to January 2011, *Escherichia coli* was detected from a raw water sample point on a single occasion at the concentration of 2 MPN/100 mL. Investigation indicated bore 1/04 contributed to this detection and contamination may have been associated with adjacent pastoral activity.

Appendix C — How do we protect public drinking water source areas?

The *Australian drinking water guidelines* (ADWG) (NHMRC & NRMMC 2004a) outline how we should protect drinking water in Australia. The ADWG recommends a 'catchment to consumer' framework that uses a preventive risk-based and multiple-barrier approach. A similar approach is recommended by the World Health Organization.

The 'catchment to consumer' framework applies across the entire drinking water supply system – from the water source to your tap. It ensures a holistic assessment of water quality risks and solutions to ensure the delivery of a reliable and safe drinking water to your home.

A preventive risk-based approach means that we look at all the different risks to water quality, in order to determine what risks can reasonably be avoided and what risks need to be minimised or managed. This approach means that the inherent risks to water quality are as low as possible. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system.

The first and most important barrier is protecting the catchment. If we get this barrier right, it has a 'flow-on effect' that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage of water to help reduce contaminant levels, disinfecting the water (e.g. chlorination to inactivate pathogens), maintenance of pipes and testing of water quality. Another community benefit of catchment protection is its complimentary nature to conservation initiatives.

Research and experience show that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That's why this drinking water source protection review is important. We should not forget that ultimately it's about protecting your health, and about protecting the catchment's water quality now and for the future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by putting the ADWG into practice, writing plans, policies and guidelines, and providing input into land-use planning.

The *Metropolitan Water Supply Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947* provide us with the tools we need to protect water quality in PDWSAs. These tools allow us to assess and manage the water quality contamination risks from different land uses and activities. We work cooperatively with other agencies in the implementation of this legislation.

An important step in maximising the protection of water quality in PDWSAs is to define priority areas and protection zones to help guide land use planning and to identify where legislation applies. There are three different priority areas.

Priority 1 (P1) areas are defined and managed to ensure there is no degradation of the quality of the drinking water source using the principle of risk avoidance.

Priority 2 (P2) areas are defined and managed to maintain or improve the quality of the drinking water source using the principle of risk minimisation.

Priority 3 (P3) areas are defined and managed to maintain the quality of the drinking water source for as long as possible using the principle of risk management.

Protection zones surround drinking water extraction points (such as bores and reservoirs), so that the most vulnerable areas may be protected from contamination.

If you would like more information about the ADWG and how we protect drinking water in Western Australia, go to < http://www.water.wa.gov.au > Managing water > Drinking water; or email drinkingwater@water.wa.gov.au.

Appendix D — Photographs

All the photographs in this appendix were taken by Nigel Mantle

Figure D1 Water Corporation signage for the Halls Creek Water Reserve

Figure D2 Bore 1/04: production bore compound fence and signage

Figure D3 Dam in P1 area, in eastern portion of water reserve

Figure D4 Halls Creek wastewater treatment plant: evaporation basin (left) and ponds (right)

Figure D5 Stockyard and cattle dip of Department of Agriculture and Food, P1 area

Figure D6 "Amnesty" bins in P1 area for surrendering quarantine risk items to the Department of Agriculture and Food

Figure D7 Concrete works in P2 area zoning semi rural

Figure D8 Leakage/spillage of stored oil

List of shortened forms

ADWG	*Australian drinking water guidelines*
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Bq/L	Becquerel per litre
DEC	Department of Environment and Conservation
HAZMAT	hazardous materials
kL	kilolitre
LEMC	local emergency management committee
mL	millilitre
MPN	most probable number
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PSC	public sector circular
PDWSA	public drinking water source area
TCU	true colour units
TFSS	total filterable solids by summation
WHPZ	wellhead protection zone
WESTPLAN–HAZMAT	Western Australian plan for hazardous materials
WQP	Water Quality Protection Guideline
WQPN	Water Quality Protection Note of the Department of Water

Glossary

Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Australian drinking water guidelines	The *National water quality management strategy: Australian drinking water guidelines 6*, 2004 (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
Department of Environment and Conservation	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.
Effluent	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2004a).
Hectare	A measurement of area, equivalent to 10 000 square metres.
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.

Most probable number	Most probable number is a measure of microbiological contamination.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA).
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.

Total filterable solids by summation	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO_4 equivalent (sulphate) or S (sulphur) in grams, Fe (iron), Mn (manganese), and SiO_2 (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
True colour units	True colour units are a measure of degree of colour in water.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.

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- WQPN no. 15: *Extractive industries near sensitive water resources*
- WQPN no. 20: *General and heavy industry near sensitive waters*
- WQPN no. 22: *Irrigation with nutrient rich wastewater*
- WQPN no. 25: *Land use compatibility in Public Drinking Water Source Areas*
- WQPN no. 26: *Liners for containing pollutants using synthetic membranes*

- WQPN no. 27: *Liners for containing pollutants, using engineered soils*
- WQPN no. 28: *Mechanical servicing and workshops*
- WQPN no. 30: *Groundwater monitoring bores*
- WQPN no. 32: *Nurseries and garden centres*
- WQPN no. 33: *Nutrient and irrigation management plans*
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