CLeanout of selected
Tennant creek production bores
1988

NOTE: report 56.3 R18 or
contains corrections to
conclusions here-in

Down-hole video inspection
Tennant creek borefield
1989
RN's 1735, 10625, 12603, 12611

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JC/9.10/AHR
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Abbreviations
m metres
L/s Litres per second
1. INTRODUCTION

Following the January 1988 earthquakes in the Tennant Creek region, Water Operations Branch reviewed all production bore data and concluded that production bore number 11 (P11) had completely silted up its lower screens and required cleaning out. Some concern was expressed that the earthquake may have altered the pumping rates of some of the bores.

Accordingly Water Resources Branch reviewed the available data, concluding that the earthquake had no measurable effect, and that other production bores would also benefit from cleanouts. Three production bores (P2, P8, P11) were cleaned out by Water Resources' test pumping crew using a duo-pipe jetting-airlift technique and were re-tested for bore performance. All three showed improved performance over their original test results.

This report describes all of the above findings. Some recommendations mainly to do with pump settings; wider-ranging recommendations are foreshadowed in a comprehensive report on current computer modelling of the aquifer. The modelling report, aimed at predicting the long term behaviour of the borefield, estimating its sustainable yield and defining measures needed to optimise its performance, is scheduled for completion this financial year (88/89).
2. PUMPING RATES

As part of the comprehensive report on the borefield pumping rates had been calculated for seven high-demand and seven low-demand weekly periods in 1987. From that calculation, average production rates for each bore before the earthquake were available. They are compared in Table 2.1 with calculated pumping rates during the nine weeks following the earthquake (25/1/88 to 27/3/88 inclusive).

The rates are calculated by dividing weekly production (from daily readings of each bore's water meter) by weekly hours run (from a weekly reading of each bore's hour meter).

<table>
<thead>
<tr>
<th>BORE</th>
<th>PRE-EARTHQUAKE: PUMPING RANGE</th>
<th>POST-EARTHQUAKE: PUMPING RANGE</th>
<th>RECOMMENDED IN BORE COMPLETION REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADOPTED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>8.1 - 8.9</td>
<td>8.6 - 8.7</td>
<td>13</td>
</tr>
<tr>
<td>P2</td>
<td>9.1 - 11.2</td>
<td>9.6 - 9.9</td>
<td>13</td>
</tr>
<tr>
<td>P4</td>
<td>12.2 - 14.0</td>
<td>13.3 - 13.8</td>
<td>13</td>
</tr>
<tr>
<td>P5</td>
<td>9.8 - 14.7</td>
<td>10.8 - 11.5</td>
<td>16</td>
</tr>
<tr>
<td>P6</td>
<td>8.5 - 11.3</td>
<td>9.0 - 10.6</td>
<td>12</td>
</tr>
<tr>
<td>P7</td>
<td>14.8 - 20.4</td>
<td>18.4 - 21.7</td>
<td>18</td>
</tr>
<tr>
<td>P8</td>
<td>9.7 - 14.1</td>
<td>14.3 - 15.1</td>
<td>20</td>
</tr>
<tr>
<td>P9</td>
<td>5.0 - 6.1</td>
<td>6.1 - 10.0</td>
<td>5</td>
</tr>
<tr>
<td>P10</td>
<td>7.0 - 10.4</td>
<td>9.3</td>
<td>14</td>
</tr>
<tr>
<td>P11</td>
<td>15.4 - 18.7</td>
<td>15.7 - 16.3</td>
<td>20</td>
</tr>
<tr>
<td>P12</td>
<td>10.1 - 10.9</td>
<td>10.4 - 11.0</td>
<td>13</td>
</tr>
<tr>
<td>P13</td>
<td>18.6 - 21.7</td>
<td>13.3 - 20.3</td>
<td>20</td>
</tr>
<tr>
<td>P14</td>
<td>6.7 - 8.4</td>
<td>7.2 - 8.0</td>
<td>7</td>
</tr>
<tr>
<td>P15</td>
<td>6.7 - 6.9</td>
<td>10.0 - 11.1</td>
<td>10</td>
</tr>
</tbody>
</table>
All except P9 and P15 are within or close to previously observed ranges, and it is concluded that no significant change has taken place. See detailed comments in the following section for information on P9 and P15.

The variations in pumping rate shown above arise mainly from the head against which the bore is pumping, which in turn is dependent on which other bores in a group are also pumping at the time. For example, P pumps 20 L/s when disconnected from the collection mains, and P11 pumps 23 L/s when disconnected.
3. TOTAL DEPTHS AND PUMP SETTINGS

Figure 3.1 is a diagrammatic representation of the bore-field and the production bores, showing construction, depths, and pump settings.

The construction of PI1 is shown in more detail in figure 6.1. The lower screens are from 49.3 m to 50.5 m. Water operations’ records showed a measured total depth of 49.35 m prior to the earthquake; ie, the bottom screens were 87% blocked prior to the earthquake. Measured depth on 20/6/88 was 48.35 m and the bore was pumped by Operations such that this increased to 49.65 m. Water Resources were then called upon to further increase the depth so that the entire bottom screen was cleared.

While PI1 was the bore with a silt-up problem causing concern, most of the bores exhibit some silting as may be seen in Table 3.1 taken from Water Operations’ records. The actual depth of silting is less important than its location relative to screens; see figure 3.1 for that information. As many of the pump settings are in or below screened intervals, it is probable that excessive turbulence introduced much material during early pumping. It is not however possible to set pumps in the preferred position above the screens as many of the older, shallower bores are starting to dewater their screens during pumping.
BORE DETAILS
PRODUCTION

KELLY WELL AREA

TENNANT CREEK

LEGEND

GRANITE
LIGHT GREY-WHITE
SILTSTONE
CLAY & SAND
CLAY & SAND
CLAY & SAND
MINOR SAND
CLAY & SAND
CLAY & SAND
OPEN HOLE
SHEETED CASING
CASED HOLE
Caisson
Closed Sump
Pump
Recommended Pumping Rate L/s
### TABLE 3.1 - PRODUCTION BORE DEPTHS

<table>
<thead>
<tr>
<th>Bore</th>
<th>Depth as constructed (m)</th>
<th>Measured depth (m)</th>
<th>Date measured</th>
<th>Fitted with airline?</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>42.6</td>
<td>36.0</td>
<td>30/1/86</td>
<td>yes</td>
</tr>
<tr>
<td>P2</td>
<td>33.5</td>
<td>30.5</td>
<td>1/85</td>
<td>yes</td>
</tr>
<tr>
<td>P4</td>
<td>36.5</td>
<td>37.0</td>
<td>9/5/85</td>
<td>yes</td>
</tr>
<tr>
<td>P5</td>
<td>32.2</td>
<td>32.0</td>
<td>12/3/83</td>
<td></td>
</tr>
<tr>
<td>P6</td>
<td>37.5</td>
<td>36.9</td>
<td>7/7/88</td>
<td></td>
</tr>
<tr>
<td>P7</td>
<td>33.5</td>
<td>33.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P7</td>
<td>36.6</td>
<td>32.2</td>
<td>5/5/87</td>
<td></td>
</tr>
<tr>
<td>P9</td>
<td>33.5</td>
<td>32.3</td>
<td>7/7/87</td>
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<td>P10</td>
<td>55.1</td>
<td>54.1</td>
<td>25/5/88</td>
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<tr>
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<td>57.0</td>
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<td>20/6/88</td>
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<tr>
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<td>54.0</td>
<td>49.5</td>
<td>19/7/88</td>
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<td>44.5</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>P14</td>
<td>66.6</td>
<td>56.4</td>
<td>13/5/86</td>
<td></td>
</tr>
<tr>
<td>P15</td>
<td>43.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Usually to sump; open hole depth as drilled was often greater. P1, P4 and P14 are open hole below the bottom of casing.

Comments on each are as follows:

**P1** - Total depth as measured 30/1/86 is still 5 m below the bottom of perforations. Pump is set in the perforated portion, perforations extend right to bottom of casing, so pump cannot be lowered past perforations. Retain present setting. Was constructed in 1967, so it is likely that the
perforated black bore casing has deteriorated significantly.

P2 - See section 4 below.

P4 - Was bailed to total depth (10 m below screens) by removal of 11.5 m of material in 1985; has not been depthed since. Is said to fork if pumped long enough. Pump is set right at the bottom of the screens which in turn form the lower part of the casing string, so the screens must be dewatering badly. Reduction in pump rate will be required if forking continues.

P5 - Measured depth is almost identical to depth as constructed. Pump set near bottom of screens. No opportunity to move below screens. Retain present setting.

P6 - Has 1.5 m of sump with almost no infill material. Recommended pump setting at the top of the sump (36 m) was intended to place the pump as much as possible beneath the screens. Pump settings have varied from 33.6 m to 35.2 m over the past ten years. The low pump setting appears to be preventing significant silting of this bore. The pump should continue to be set as deeply as possible.

The completion report recommended against equipping with a submersible pump, presumably because the motor would be in a stagnant portion below the screens and therefore be subject to possible overheating. It is noted that this is the only bore in the Kelly Well basin which has been equipped with a submersible pump.

P7 - Similar to P6: 1.2 m of sump with 0.5 m infill, and with a recommended pump setting at the top of the sump. Pump should continue to be set as
deeply as possible.

P - See section 5 below.

P9 - Infrequently used and then only for filling road watering tankers. Has the lowest production rate in the borefield and is said to run dry with ease. Pump setting has been progressively increased from the recommended depth at the top of the screens to approximately two thirds down the screens in an attempt to prevent forking. Note however that recent usage has averaged 9 - 10 L/s for short periods. It may be that the bore is effectively over-equipped, particularly when not pumping against a head generated by other bores simultaneously pumping into the collection mains.

Has 1.2 m of material in the bottom; sump is affixed directly to screens. There is no good reason to attempt rehabilitation of this bore. It and several other shallow bores in that part of the borefield will be replaced with deeper bores in due course.

P10 - Has 6.6 m of sump with only 1 m of infill material. Pump setting is satisfactory at 0.7 m above the top screen; setting should not be increased but may be decreased by 1 or 2 m if ever required.

P11 - See section 6 below.

P12 - Has 6.5 m of sump with 4.5 m of infill material accumulated over five years of operation. If the accumulation rate is linear, two years remain before screens will be affected; it is more likely that the rate was greatest when first pumping and that more than two years will elapse before any action is necessary. The recommended pump setting of 34 m is right at the start of the top screens.
and should be decreased to between 32 and 33 m to decrease screen turbulence.

P13 - Has apparently not been depthed since commissioning. May be expected to be similar to P12. Pump setting is acceptable at 0.6 m above the top screen. Should be depthed when convenient.

P14 - Is the only production bore without screens or perforated casing, and is the second lowest producer in the borefield. Recommended pump setting of 40 m is right at the bottom of the casing and is too low; 38.5 m as currently used by Water Operations is more satisfactory. Total depth records are conflicting: 56.4 m was measured in July 1985 and 76.4 m in May 1986. Should be re-depthed when convenient.

P15 - Had apparently not been depthed since commissioning, and would be expected to be similar to P12 and P13. Pump setting is between the top and second screens and is acceptable at 33 m, being 1 m above the second screens. The 50% increase in average production rate since 1987 is due to re-equipping with a more powerful motor.

However, information recently to hand has measured depth at 37.3 m, that is 6.5 m of material has accumulated in the 5 years since commissioning in November 1982. The bottom length of screen is therefore completely blocked. A tentative conclusion is that the lowest screens are not contributing significantly to the supply (as is the case for P11).

This could checked to an extent by taking airline readings of drawdown in the bore and comparing them with the step test results from the original test-pumping. Unfortunately P15 is not equipped
with an airline. It should therefore be step-tested and cleaned out in the same manner as was P11 when next convenient (i.e., when next pulled for routine maintenance). No urgency is attached to this as the production rate has not suffered; the retesting is more to confirm the locations of producing zones within the aquifer.

It will be noted that changes to a number of pump settings are recommended. Table 3.2 shows the setting originally recommended in bore completion reports, those actually used over the past few years, and the settings now recommended as a result of this review.
<table>
<thead>
<tr>
<th>Bore</th>
<th>Original recommended pump setting (m)</th>
<th>Actual Pump Setting (m)</th>
<th>Range of acceptable pump settings (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>30.0</td>
<td>27.0</td>
<td>27 - 30</td>
</tr>
<tr>
<td>P2</td>
<td>30.7</td>
<td>26.8 - 21.0</td>
<td>21 *</td>
</tr>
<tr>
<td>P4</td>
<td>?</td>
<td>27.6</td>
<td>26 - 27.6</td>
</tr>
<tr>
<td>P5</td>
<td>30.0</td>
<td>30.0</td>
<td>30 - 32</td>
</tr>
<tr>
<td>P6</td>
<td>36.0</td>
<td>33.6 - 35.2</td>
<td>36.0</td>
</tr>
<tr>
<td>P7</td>
<td>32.3</td>
<td>32.3</td>
<td>32.3</td>
</tr>
<tr>
<td>P8</td>
<td>22.0</td>
<td>21.0</td>
<td>21 - 22</td>
</tr>
<tr>
<td>P9</td>
<td>23.0</td>
<td>29.5</td>
<td>29.5*</td>
</tr>
<tr>
<td>P10</td>
<td>39.0</td>
<td>39.1</td>
<td>37 - 39</td>
</tr>
<tr>
<td>P11</td>
<td>37.0</td>
<td>38.5 - 35.5</td>
<td>35 - 36.6</td>
</tr>
<tr>
<td>P12</td>
<td>34.0</td>
<td>34.0</td>
<td>32 - 33</td>
</tr>
<tr>
<td>P13</td>
<td>30.0</td>
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<td>29 - 30</td>
</tr>
<tr>
<td>P14</td>
<td>40.0</td>
<td>38.5</td>
<td>37 - 38.5</td>
</tr>
<tr>
<td>P15</td>
<td>33.0</td>
<td>33.0</td>
<td>32 - 33</td>
</tr>
</tbody>
</table>

* See additional comments in text
Production bore P2 (RN 5701), the only production bore to have been constructed with a gravel pack, was completed in 1967. Figure 4.1 shows construction details. Total casing depth was 33.5 m, and measured depth was 30.5 m, so 3 m of material had accumulated; this was assessed to be "rust and scale". Measured depth after jetting was 34.1 m. It is recommended that Water Operations examine their records to determine the period over which the material accumulated, and deduce an accumulation rate for this and for the other production bores.

Original test pumping was incomplete, suffering both motor and measuring equipment failures; some results have been extracted and are plotted in figure 4.2 together with 1988 results. Note that the bore is now performing more efficiently than in 1967. The available drawdown is now however significantly less: pump setting minus standing water level was 30.8 - 12.2 = 18.6 m in 1967, but only 21.8 - 15.8 = 6.0 m in 1988. In 1988, at the 300 minute mark when the rate was increased to 15.1 L/s, the bore forked. It was pumped on the fork (constant drawdown test) for two hours and the discharge stabilized at 12.7 L/s.

While running the pump it was noted that significant snagging occurred in the perforated casing. It seems that the casing is rusting out and starting to collapse inwards.

This bore is one of the oldest and shallowest in the borefield and will be one of those replaced by new, deeper bores in the next stage of work in the borefield. In the interim however it is recommended that it be re-lined with 150 mm PVC casing to prevent potential snagging of equipment and pumping of small pieces of rusted metal. Relining should be with blank PVC casing.
from surface to just below the pump setting of 21 m and the remaining length to the bottom (approximately 12 m) should be slotted. The casing may be seated on the sound formation at the bottom. Pump setting shown in the Water Operations summary listing is 26.79 m however it is understood that the setting actually in use is 21 m; 21 m should continue to be used, with the option of increasing it if necessary given the protection afforded to the pump by a PVC liner.

The recommended pumping rate was 12.6 L/s, however the weekly pumping returns over the last 12 months show an average of 10 L/s. This lower rate should be retained in the light of test pumping results. The bore should be equipped with an airline when re-installing so that any increased well loss through the PVC perforations can be quantified.
CONSTRUCTION DETAILS

DEPTH (m) | BORE CONSTRUCTION

340 mm Ø hole
6 - 12 mm gravel pack
12 - 19 mm gravel pack
Standing water level 24-1-67
Standing water level 8 - 9 - 88
122
210 Actual pump setting
268 Pump setting shown in records
301 Depth prior to clean out
307 Recommended pump setting
341 Depth after clean out.

TENNANT CREEK - KELLY WELL P2 (RN 5701)

2676-40-144 FIGURE 4.1
STEP DRAWDOWN TEST
TENNANT CREEK PRODUCTION BORE 2
2682-40-141
RUN 5701
0 7-6-67 12-9-88
DRAWDOWN (metres)
0 1 2 3 4 5 6
100 TIME (minutes)
1000 18-9 L/S
15-1 L/S
11-3 L/S
9 L/S
6 L/S
5. P8 CLEANOUT AND RETESTING

Production bore P8 (RN 10623) was completed in 1973 with a casing string comprising 22.9 m of 200 mm blank casing, 9.4 m of 3 mm screens, and a further 4.3 m of blank casing as a sump; see figure 5.1 for construction details.

Recommended pump setting of 22 m was at the top of the screens, and recommended maximum continuous pumping rate was 20 L/s. Actual pump setting of 21 m is satisfactory. Apart from a long sump it is very similar in construction to P5 through P9 inclusive (they were all drilled as part of the same augmentation program).

The pump setting for P9 was also recommended at the top of the screened interval, however those for P5, P6, and P7 were all at or near the bottom of the screens. The rationale behind this distinction is not known. As one of the highest yielding bores in the field, P8 is equipped with a backup diesel motor in addition to the normally used electric motor.

Measured depth in 1987 was 32.2 m compared with 32.3 m to bottom of screens and 36.6 m to sump. Five metres of material was jetted out bringing measured depth to 37.3 m (the apparent extra depth probably due to differences in measuring point). Measured depth in 1981 was 37.3 m (presumably after a similar cleanout), giving a rate of accumulation of approximately one metre per annum. The material removed was mostly rust and scale plus some sand; some casing deterioration is clearly occurring, but should be insignificant as the productive zone is set with stainless steel screens.

The step-testing (figure 5.2) shows this bore to be more efficient now than when originally tested: the near well aquifer has developed somewhat. Recommended production rate is 20 L/s, however pumping over the last
12 months has averaged 13 L/s. For the time being no attempt should be made to increase the average rate as the available drawdown is only 8 m, this pump being set just above the top of the screens. Recommendations on possible rate increases will be made in the forthcoming report on the borefield modelling project.
CONSTRUCTION DETAILS

DEPTH
(m)  BORE
CONSTRUCTION

8.9  Standing water level 7-2-1980

13.7  Standing water level 9-9-1988

21.0  Actual pump setting

22.0  Recommended pump setting

203 mm ø Stainless screens,
3 mm aperture screwed to casing.

32.2  Measured depth 5-5-87

37.3  Depth after cleanout

TENNANT CREEK – KELLY WELL  P8 (RN 10623)

2677-40-145  FIGURE 5.1
6. P11 CLEANOUT AND RETESTING

Production bore 11 (RN 12603) was completed in 1980 with a casing string comprising two sections of 1 mm screens, as shown in figure 6.1

During drilling the airlift yield reached 8 L/s at 44 m and did not increase thereafter, so there is some doubt that the lower screens contribute much to the yield. After test pumping the bore was recommended at 20 L/s.

Recommended pump setting was just above the top screens, at 37 m. Actual setting at 38.5 m is within the top screens, leading to possible turbulent conditions during pumping. The recommended setting of 37 m is a maximum; the pump has been re-set at 35.5 m and should remain there. As one of the highest-yielding bores in the field, P11 is also equipped with a backup diesel motor.

Although drilled in 1980, P11 was not placed in service until May 1983. The first available measured depth thereafter, in October 1986, was 49.3 m, and in June 1988 48.3 m, completely blocking the lower screen. Water Operations were able to increase this to 49.6 m using a submersible pump; the screens ending at 50.5 m were still partially blocked. Jetting by Water Resources increased the depth to 50.2 m where a solid object, thought to be metallic, was encountered. However, from the following test pump results, the lower screen contributes nothing to the bore yield, and could be allowed to silt up permanently without affecting production rate or internal drawdown during pumping. It would appear that some damage was done, or foreign object(s) introduced, before equipping of the bore.

Before cleanout the bore was backfilled with clean sand to completely obscure the lower screen, sealed with a bentonite plug, then step tested at the same rates as the original test. The results, labelled 5/9/88, are
plotted in figure 6.2. After cleanout, with the lower screen now 80% clear, the same test was repeated, and is labelled 7/9/88. As can be seen by the almost identical drawdowns at each pumping rate, the lower screen is contributing nothing to the yield from the bore. Comparison with the original 1980 results shows that development has occurred with well losses now being some 15% lower, so it is likely that the lower section of screen never contributed to the bore's yield.

Recommended pumping rate is 20 L/s. Production has averaged 18 L/s over the last 12 months. Given the improved performance identified above, it may be possible to increase the recommended production rate from P11 (and possibly from other production bores); this option will be examined in the borefield modelling project report.
TENNANT CREEK - KELLY WELL P11 (RN 12603)

2678-40-146

FIGURE 6.1

CONSTRUCTION DETAILS

**DEPTH (m)**

<table>
<thead>
<tr>
<th><strong>BORE CONSTRUCTION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing water level 28-10-1980 7.8</td>
</tr>
<tr>
<td>Standing water level 5-9-1988 11.3</td>
</tr>
<tr>
<td>305 mm Ø steel casing</td>
</tr>
<tr>
<td>203 mm Ø steel casing</td>
</tr>
<tr>
<td>35.5</td>
</tr>
<tr>
<td>37.0</td>
</tr>
<tr>
<td>38.5</td>
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<tr>
<td>49.3</td>
</tr>
<tr>
<td>50.5</td>
</tr>
<tr>
<td>57.0</td>
</tr>
</tbody>
</table>

**203 mm Ø stainless screens, 1 mm aperture welded to casing.**
As drawdowns in a number of production bores are approaching, or have reached, the top of screens and perforations, they should all be fitted with serviceable airlines so that drawdown may be economically monitored on a regular basis.

P2 Reline with PVC and retain new pump setting of around 21 m with a pumping rate of 10 L/s. Ensure airline is serviceable when re-installing so that any increased well loss through the PVC perforations can be quantified.

P5, P6, P7 Pumps should continue to be set as deeply as possible to prevent build-up of material and to encroach as little as possible on the screens, with the possible exception of the submersible in P6.

P8 Retain current reduced production rate of 13 L/s.

P9 From an economic point of view it may be abandoned the next time it requires any work.

P11 Retain amended pump setting of between 35.0 and 36.5 m. Cleanout not required even if bottom screens silt up completely.

P12 At next overhaul reduce pump setting to between 32.0 and 33.0 m.

P14 Retain amended pump setting of 38.5 m.

P15 When next pulled for maintenance, conduct a test pump, cleanout, test pump program as was performed on P11.