CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

To dispose the PW generated in the field selected for this study is called M field. The targeted formation of M field is shallow aquifer and having high porosity, permeability and storage volume, therefore the formations were selected to dispose PW. There are 21 reservoirs located into the formations and three highly deviated wells are penetrating the reservoirs. Among the three wells, two wells MN-1 and MN-2 are drilled only to inject PW into shallow aquifer sands, therefore in this thesis the discussion is limited only these two injectors. This study thus focuses on the investigation of injection capacity and performances of shallow aquifer by the two injectors. Furthermore, best sand candidate for water injection also be recommended.

The objective of this study is to investigate the capacity and performances of A and B sand units of M filed. To investigate the capacity and performance of those two sand units, reservoir simulation was perform. The simulation work consists of two steps of study. The first step is reservoir model construction and initializes the model; data and every details of reservoir model construction are described in Chapter IV. The last step was simulation to estimate the capacity and performances of those two sands by the two injectors over 20 years using three different models.

The conditions imposed in this study can be listed as follows:

- In this model area there are two injection wells and for this aquifer less data are available in details. However, many data were postulated from nearby well or nearby location for simulation input.
- Reservoir modeling of the targeted aquifer is presented based on prior interpretation of log data.
- Water is slightly compressible with constant compressibility and the flow is isothermal.
- Since there are several layers intersected by the wells and the two wells were used for single well and multi wells options to inject into every layers of the two sand units to select the best sand unit.

- The maximum injection rate is limited by pump capacity and is set at 13000 STB/D for each well.
- All the cases for both of the wells were simulated for 20 years long.

The parameters affecting injection capacity and performances were selected for sensitivity analysis are injection rate, single well and multi well injection. By varying these parameters, the simulation organizes into 9 cases for HM. To introduce heterogeneity into the model, two models were created by introducing channels into HM namely Channel-I and Channel-II. Therefore, under two scenarios three models were run for 27 cases and impact of sensitivity variables were discussed. In addition, in intermittent injection another 4 cases were run to investigate the IP gain. During injection care should be taken so that injection pressure must not be high enough to create formation fracture in the targeted sand units. It is worthwhile to assume that no particle filtrate or formation damage effect.

The following conclusion can be drawn from this study:

- Homogeneous model gives the highest CIV. Channel-I and Channel-II models give lower CIV compare to HM because presence of channels reduces the PV.
- Initial well injection rates upto 13000 STB/D can be maintained throughout in single well injection for HM. Maximum cumulative injection volume increases with injection rate.
- In HM model with single well injection pattern, both wells behave in the same manner as the petrophysical properties at the well location are also the same. Therefore, well location does not matter.
- In channel model, well MN-1 gives lower CIV because it intersects less channels compare to MN-2. Therefore, well placement is important.
- In channel models both wells have influences on each other injection performance in multi well injection case. Well MN-2 has more pronounced effect on MN-1 injection performance than vice versa.

- After reaching fracture pressure and the wells are controlled by THP, CIV of different cases are converging because of the declination of well injection rates and confinement of models.
- CIV can be maximum 35.2% of gas PV.
- The initial gas pore volume has an effect on the pressure build up as water is injected.
- Higher kh layer can accept more water injection volume.
- A is the best sand unit in terms of CIV and it intakes from 88.3% to 95.7% of CIV for both well injection and from 92.9% to 98.9% of CIV for single well injection.
- In channel models, IIs decrease compare to HM because of flow resistance out side of channels.
- By intermittent injection, injection rate can be gained after the shut in period.

The following points are recommended for the future of M field injection operations:

- Run PLTs to verify which sands are open to flow.
- Since matrix injection is operationally complex than other disposal options, therefore monitoring is essential task during injection. Pressure can be monitored to ensure it does not exceed the maximum allowable injection pressure to avoid fracturing. Permanent downhole pressure gauges can be installed.
- In M field, PW is coming from deeper formation and injected into shallow aquifer. Therefore, compatibility between PW and injected zone formation water should be checked. The PW may contain dissolved oxygen, chemicals and bacterial components which may result in scale and sludge formation resulting permeability degradation around the injection well. Such permeability degradation can plug the formation around the injection well.
- In matrix injection solids deposition resulting formation plugging in a limited area around the injection well. The extent of this area depends on the formation pore throat size and size of the contaminant particles which

are plugging the formation (Abou-Sayed, *et. al.*, 2007). Therefore, water quality (TSS) in an important variable in this injection process.

- Substantial filtering may be required to remove the solid particles present in the PW for matrix injection. Therefore, pilot tests are recommended to evaluate field filtering requirements.
- Under some circumstance, it may be necessary to suspend water disposal by injection or it may be insufficient water disposal by injection, therefore, back up plans should be under considerations.

The following point is recommended for future study:

- To introduce heterogeneity into the model, channels were introduced into HM and the channels were homogeneous. But in reality downgrade sands are located at channel margin. In the middle of the channel especially in the direction of bottom the sand quality is high that exhibit good reservoir quality. Therefore, incorporation of heterogeneity in the channel is recommended to carry out as future study in order to make more realistic estimate of sand injection capacity and performances of M field.