

RECOMMENDED CHANGES TO THE CAPP

(underlined indicates additions, strike through indicates deletion)

1. All typographical errors will be corrected.

2. All changes in the ordinance/resolution will be reflected in the CAPP where the ordinance is directly quoted (for example: Page 3-30 through 3-32 – under Site-Specific Investigations and Page 5-6 through 5-12).

3. *Acknowledgments*

Chris Moody (Wyoming Groundwater), Karl Taboga (University of Wyoming PhD candidate), Tony Hoch (Professional Geologist), and Keith Clarey (Wyoming State Geological Survey) provided edits, recommendations, and insight to the technical and scientific aspects of the CAPP, specifically the delineation of the Casper Aquifer Protection Area.

~~Chris Moody, Wyoming Groundwater, provided invaluable edits, recommendations, and insight into both the Casper Aquifer and the community. The revised CAPP is a reflection of his professional knowledge and personal interest in ensuring protection to the Casper Aquifer. Karl Taboga, University of Wyoming PhD candidate, also provided a professional review of the delineation process of the Casper Aquifer Protection Area.~~

4. *Page ii. Changes to #2 and #6 will be placed after #5.*
 - New contamination pathways – New wells and deep excavation which weaken the integrity of the confining layer may provide a direct conduit to the Casper Aquifer or reduce the hydraulic integrity of the barrier provided by the Satanka Shale that overlies the Casper Aquifer.

6. There are characteristics of the Casper Aquifer which may render the aquifer more susceptible to contamination and include: drainages, fractures, faults, folds, dissolution cavities, exposed sandstone, shallow depth to groundwater, and thin soils.

5. *Page ii. Following the list of items that make the Casper Aquifer vulnerable.*

The western boundary of the CAPA was extended to the west of the previous boundary. The previous western boundary of the CAPA was calculated to be the line where there was at least 75 feet of Satanka Shale overlying the Casper Aquifer. The boundary was extended to the west on section, quarter-section, and quarter-quarter section lines to provide continuous protection between Zones 1 and 2, provide an additional buffer to the calculated 75 foot line because there are known places where the line was inaccurate, and to provide easier implementation.

6. *Page ii. Under Contaminant Management Plan after item #2.*
 3. Conduct the East Laramie/Albany County Wastewater Disposal Needs Assessment and Plan.
 4. Fund a joint City/County staff position that will be responsible for implementing the CAPP.

Change the other numbers in this list to reflect the correct numbers.

7. Page 1-4. Paragraph starting with “Figure 1-3 shows the location . . .” 2nd sentence.

All of the City wells are on fenced property owned and controlled by the City of Laramie.

Wells at the Solider Springs Wellfield, Spur No. 1 well, and Turner No. 2 well are all on fenced property owned and controlled by the City of Laramie. The wells at Pope Springs are located on City property but are not fenced. Spur No. 2 well and Turner No. 1 wells are also located on City property but only a small area around the wellheads is fenced.

8. Page 1-7. Last paragraph of the Chapter, 1st sentence.

Albany County Planning and Zoning Commission, and (the Albany County Planning and Zoning Commission was incorrectly called Albany County Planning Commission).

9. Page 2-2. Paragraph starting with “Due to continuing community concern...” following the last sentence in this paragraph.

The TAC was a group of interested individuals including landowners, professionals, and City and County government representatives. The EAC was included as a representative on the TAC but chose to otherwise be uninvolved due to their lack of expertise on the subject. The concerned citizens were incorporated by meeting with several individuals at the beginning of the update so that WHPA could understand the issues surrounding the CAPP and associated regulations. The concerned citizens and TAC members are listed in the acknowledgments.

10. Page 3-1. The list of items that discuss the vulnerability of the Casper Aquifer will be the same as the Executive Summary list.

11. Page 3-2. 3rd paragraph. After sentence ending with July 25, 1999.

The boundary of the CAPA was delineated as follows: the eastern boundary was the ridge of the Laramie Mountains, the northern boundary was north of the Spur Anticline, the southern boundary was south of the Simpson Springs Anticline, and the western boundary was calculated from a dip formula where it was estimated that 75-feet of Satanka Shale would be overlying the Casper Aquifer.

12. Page 3-2. Paragraph before Geology and Hydrogeology of the Laramie Area heading. After last sentence in the paragraph.

The western boundary of the CAPA was straightened and moved to the west. The western boundary was changed to reflect the fact that there are known places where there is less than 75 feet of Satanka Shale overlying the Casper Aquifer along the calculated line (depicted in Figure 1-3 as the 75 feet of Satanka Shale). At Solider No. 1 well there is 41 feet of Satanka Shale but the calculated 75 feet line is to the east of Solider No. 1. At Turner No. 2 well, there is 74 feet of Satanka Shale so the calculated 75 feet line should coincide with Turner No. 2 yet the calculated line is east of Turner No. 2. At Spur No. 1 well there is 54 feet of Satanka Shale and yet the calculated 75 feet line is very near that well when the actual line should be further to the west of the Spur No. 1. Since there are known areas where the calculated line is inaccurate, it was

decided that the western boundary should be moved to ensure that at least 75 feet of Satanka Shale was overlying the Casper Aquifer. Additionally, the western boundary was moved to ensure continuous protection between Zones 1 and 2. In previous delineations there was a gap of protection between Zones 1 and 2. Finally, the line was straightened and moved to section, quarter section, and quarter-quarter section lines to provide for easier implementation of the CAPP.

13. *Page 3-13. After last sentence in the Porosity of the Casper Aquifer paragraph.*
(see Table 3-1).

14. *Page 3-18. Following the Thin Soils paragraph.*

The paragraph regarding Shallow Depth to Groundwater was accidentally removed from this version. Re-incorporate the following paragraph under the heading "Shallow Depth to Groundwater"

Areas where the depth to groundwater is relatively shallow are also potentially vulnerable to contamination. There is the potential for greater natural remediation as the depth to groundwater increases. Areas where groundwater is close to the ground surface have the potential, where no confining layer is present, for the rapid infiltration of contaminants from the ground surface to the saturated zone.

15. *Page 3-18. Following Shallow Depth to Groundwater Paragraph.*

Drainages, faults, and fractures expressed at the surface allow for rapid aquifer recharge. This water can transport contaminants into the Casper Aquifer with little or no attenuation. The other features, dissolution cavities, exposed bedrock, thin soils, and shallow depth to groundwater, increase the vulnerability of the Casper Aquifer but not to the same degree as drainages, faults, and fractures. Dissolution cavities are generally underground and are therefore a less direct pathway than conduit flow features expressed at the surface. Limestones and sandstones make up the exposed bedrock within the CAPA. Limestone increases the vulnerability of the Casper Aquifer primarily through its ability to shed water and contribute to increased overland flow into the drainages, faults, and fractures. Sandstone has greater permeability than limestone and does allow water to infiltrate but at a slower rate than can conduit flow. Thin soils increase the vulnerability of the Casper Aquifer because there is less biological and physical attenuation of a contaminant. Shallow depth to groundwater also increases the vulnerability because there is less distance between the surface and groundwater and therefore less attenuation distance.

It is recommended that the amended regulations deal with the greatest risks by having setbacks of 100-feet from drainages, faults, fractures, and folds expressed at the surface. Additionally, the drainages, faults, fractures, and folds are the most discreet features and setbacks can reasonably be established.

16. *Page 3-26. 3rd paragraph on the page.*

The original west boundary of Zone 3 was delineated based on drilling data and a set of assumptions about the geology and hydraulics of the Casper Aquifer and Satanka Shale. This original boundary is now designated as the 75 feet line (Figure 1-3). The 75 feet line represents a ~~the calculated~~ boundary calculated from a dip formula (Figure 3-7) where there is an estimated

~~calculated~~ 75 feet of Satanka Shale overlying the Casper Aquifer. However, it is known that in several instances the calculated line of 75 feet of Satanka Shale is inaccurate. At Solider No. 1 well there is 41 feet of Satanka Shale but the calculated 75 feet line is to the east of Solider No. 1. At Turner No. 2 well, there is 74 feet of Satanka Shale so the calculated 75 feet line should coincide with Turner No. 2 yet the calculated line is east of Turner No. 2. At Spur No. 1 well there is 54 feet of Satanka Shale and yet the calculated 75 feet line is very near that well when the actual line should be further west of the Spur No. 1. Since there are known areas where the calculated line is inaccurate, it was decided that the western boundary should be moved to ensure that at least 75 feet of Satanka Shale was overlying the Casper Aquifer.

In order to account for the uncertainty in local geology and to allow for effective implementation of the CAPP, the west boundary of CAPA Zone 3 has been straightened and moved to the west of the calculated 75 feet line. The west boundary of Zone 3 now provides an additional buffer to the calculated line of 75 feet of Satanka Shale to ensure greater protection of the Casper Aquifer. Additionally, the western boundary was moved to ensure continuous protection between Zones 1 and 2. In previous delineations there was a gap of protection between Zones 1 and 2. Finally, the line was straightened and moved to section, quarter section, and quarter-quarter section lines to provide for easier implementation of the CAPP. The west boundary of Zone 3 now follows quarter-section, half-section, and section boundaries for unambiguous definition of the CAPA and, most importantly, allows for a continuous zone of protection between Zones 1 and 2.

17. *Page 3-28. Last paragraph on the page and continued onto Page 3-29.*

With Zone 2 defined as the outcrop area of the delta and epsilon members, including the calculated 75 feet of overlying Satanka Shale and the extension of the western boundary west of the 75 feet line (west boundary of the CAPA), the remainder of the CAPA, east of the delta member to the topographic divide of the Laramie Range, is designated as Zone 3.

18. *Page 3-32. Under Recommended Investigations #1.*

1. Establish routine measurement of water levels and water quality in wells completed in the Casper Aquifer in the Laramie area and update potentiometric maps. Currently, the City of Laramie monitors the production wells for water-quality parameters on an annual basis. Water levels are recorded continuously at all production wells and at the Spur monitoring wells.

19. *Page 4-10. Limestone quarries bullet.*

- **Limestone quarries.** Limestone quarries use fuel and blasting materials that if improperly handled may contaminate the aquifer. The blasting materials are consumed during the detonation but could contaminate the aquifer if improperly handled or stored.

20. *Page 4-10. Agricultural land use bullet.*

- **Agricultural land use.** Waste from commercial concentrated livestock facilities and applications of fertilizers and pesticides pose a risk from agricultural land use to the Casper Aquifer. General livestock grazing poses much less of a threat to groundwater than commercial concentrated feeding operations.

21. *Page 5-4. Prohibition of Various Land Uses.*

The City and County have identified prohibited land uses in the APO such as gas stations, landfills, and facilities that store or dispose of hazardous materials. A list of prohibited activities can be found in Table 5-1.

22. *Page 5-4. Cluster/Planned Unit Development (PUD) Design*

Cluster/PUD design allows for an area of small lot development in association with a conservation easement as a way that limits the overall development density to a level consistent with the goal of protecting the Casper Aquifer. Additional benefits of allowing Cluster/PUD designs are reduced costs to the developer, greater flexibility for the developer, and potential to avoid vulnerable features while still maintaining development potential.

23. *Page 5-4. Subdivision Regulations and Codes under Performance Standards*

Performance standards may be used to limit the impact of development on water quality. Performance standards could include standards for stormwater runoff, sewage effluent standards, and BMPs that may reduce contaminants that enter stormwater. Performance standards can be enacted during any stage of development including during the site-specific investigations.

24. *Page 5-6. Zone 1 Recommendations – Security*

~~Currently the wells are secured with fencing and are controlled by the City of Laramie.~~

Since not all wells are fenced, the highest priority for Zone 1 security should be to fence and secure the Pope Spring wells. Second, the entire Zone 1 area should be fenced for Spur and Turner wellfields rather than the current security which includes fencing of only a small area around the wellheads.

25. *Page 5-11. Remove Figure 5-1 from document. Rename Figure 5-2 to Figure 5-1.*

26. *Page 5-12. After Exception for Sewer and Water Lines*

City of Laramie Unified Development Code (heading)

It is recommended that the amended Aquifer Protection Overlay Zoning Ordinance and the CAPP be incorporated into the City of Laramie's Unified Development Code. Incorporating the CAPP and amended ordinance into the Unified Development Code will result in consistency within the City and a single source of information for developers within the City.

27. *Page 5-12 and 5-13. Groundwater Monitoring*

Currently, the City of Laramie monitors all municipal production wells on an annual basis for ~~major cations, anions, and metals~~ major microorganisms, disinfectants, disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides as required by EPA. Water-quality results are compared to historical levels. If the results show that concentrations have increased over historical levels, the water is immediately re-sampled. If the second sample again shows higher concentrations, more detailed sampling is undertaken and a study is initiated to identify the source of contamination. Water levels are measured continuously ~~monthly~~ at all of the municipal production wells and at Spur monitoring wells #7, #8, #10, #11, and #12.

To date, there has not been a systematic, aquifer-wide, long-term groundwater monitoring program to assess water quality in the Casper Aquifer. All of the potential contaminant sources outlined in Chapter 4 may have measurable impacts on water quality but there is not enough data available to assess water quality trends. Groundwater monitoring should be used to establish baseline water quality and to understand the impacts from existing and future development on the Casper Aquifer.

One major concern is the septic systems associated with several subdivisions in Albany County. Wastewater effluent, specifically nitrates and bacteria, from these subdivisions may have measurable impacts to the community's groundwater supply. While septic systems are a concern, all potential contaminant sources should be monitored through the systematic and long-term study of water quality in the Casper Aquifer. The groundwater monitoring network can assess the water quality and quantity near potential contaminant sources. For example, long-term monitoring wells should be established near mining operations so that the impacts of mining are fully understood.

Groundwater Monitoring Recommendations

Groundwater Monitoring Program

It is recommended that the City and County develop a program to routinely collect groundwater samples and water levels throughout the CAPA to establish baseline water quality data and to evaluate changes in groundwater quality over time. The baseline data collected from this program should be used to set standards for quantifying contamination in the Casper Aquifer. A systematic monitoring program has a secondary benefit of increasing understanding of the Casper Aquifer. The City of Laramie should continue to evaluate water-quality at the City wells in the current manner of comparing current results to historical concentrations and initiating additional sampling when results show increased concentrations.

28. *Page 5-14. 1st full paragraph.*

The assigned City/County staff would be the public contact for information regarding the CAPP and CAPA. The staff would be responsible for providing public education to both adults and children including such topics as water conservation and protection, disposal of hazardous wastes, BMPs, and general groundwater education. The groundwater monitoring program should be used to educate the public about water quality and water levels in the Casper Aquifer. Particularly, the residents living in the CAPA may benefit from sampling residential wells and understanding their ability to protect their own drinking water. The City/County staff would ensure that recommendations in the CAPP are implemented.

29. *Page 5-15. Under On-site Wastewater Treatment Systems/Septic System Recommendations*

East Laramie/Albany County Wastewater Feasibility Study and Plan (this is a new heading)

The City of Laramie and Albany County will work cooperatively to develop an East Laramie/Albany Wastewater Feasibility Study in an effort to assess groundwater quality impacts from residential septic systems. This study will:

1. evaluate the Casper Aquifer water quality within and downgradient of subdivisions within the CAPA (at a minimum this will include a survey of nitrate concentrations);
2. evaluate the costs and risks associated with residential septic systems and alternative wastewater disposal systems;
3. determine if and where alternatives to on-site wastewater disposal is needed;
4. examine alternatives (such as advanced septic systems, centralized septic systems, and sewer) to on-site wastewater disposal systems and feasibility for the CAPA; and
5. evaluate both fiscal and engineering aspects of the alternatives for areas within the CAPA that need waste disposal systems other than septic systems.

The feasibility study will be the first step in determining the impacts of residential septic systems and therefore should begin immediately (2008). Due to the intense interest this recommendation

CAPA will be willing to participate in the sampling that will be required for this study.

30. *Page 5-15. Under On-site Wastewater Treatment Systems/Septic System Recommendations*

~~Due to a high level of concern regarding water-quality impacts from septic systems, the City and County should immediately begin the East Laramie/Albany County Wastewater Feasibility Study (see East Laramie/Albany County Wastewater Feasibility Study and Plan section for further details) extend sewer lines to serve the high density subdivisions east of the city limits or the subdivisions should form sewer or improvement districts (Figure 5-1).~~

All future subdivisions within the County that have housing densities greater than 10 35 acres (Miller and Ortiz, 2007) should be required to connect to the City's sewer system or provide a centralized wastewater disposal treatment facility . The cost for this increases in sewer capacity due to future development would may be assessed to the developer. The City should update its Sewer Master Plan to address increasing sewer capacity east of Laramie as needed to serve future existing and anticipated high-density (less than 10 acres per house or other use requiring wastewater disposal) subdivisions in the CAPA. The City and County should work together to determine incentives, grants, and other financial opportunities for areas where on-site septic systems are either prohibited in the future or areas where the Needs Assessment Study finds that existing systems need to be replaced with alternative systems.

Underground Injection Control (UIC) Class V subclasses 5E3, 5E4, and 5E5 are permitted in the CAPA to allow areas that can not be served by City sewer an alternative. UICs are permitted by WDEQ and the City of Laramie and Albany County should request WDEQ to notify them through the public notice process of all proposed UICs. Through the public notice, the City of Laramie and Albany County should request that the Casper Aquifer be considered when permitting and establishing requirements for the UIC facility. WDEQ can attach monitoring and operational requirements when permitting UIC facilities.

~~City and County residents will have to bear much of the costs for sewer line extension and maintenance where City sewer is extended or other centralized wastewater treatment systems are installed. A Wastewater Service Area could be created between the City and the County to address this concern. A 'sunset date' should be established as part of the APO ordinance whereby the City and County would notify property owners in high density subdivisions near the City that the City intends to establish sewer service to specific areas within seven (7) years and affected property owners should plan for a defined economic impact to their property in terms of that schedule.~~

~~For those high density subdivisions (greater than 1 septic system per 35 acres) that are too far north or south to reasonably be served by City sewer, a centralized wastewater disposal facility and/or sewer district should be developed (Figure 5-1). These centralized systems should also be in place within seven years. The centralized wastewater disposal systems would be required to meet the WDEQ standards for municipal wastewater systems as defined in Chapter 11 of the WDEQ's Water Quality Rules and Regulations and State Statue 35-3 and 35-11.~~

31. *Page 5-17. Hazardous Material Spills Along Interstate 80 (I-80).*

Interstate 80 (change heading to reflect the following additional information)

Stormwater from I-80 carries oil, grease, metal particles from tires and brake pads, and other

automotive fluids and particles from the road over the recharge area. The stormwater then infiltrates into the Casper Aquifer along with any associated contaminants.

32. *Page 5-19. Cleaning I-80. (new heading under I-80 Recommendations)*

The City of Laramie and Albany County should work with WYDOT to ensure regular street sweeping of I-80. WYDOT should properly dispose of all materials in a landfill or other appropriate disposal facility.

33. *Page 5-19. MOA/MOU. (new heading under I-80 Recommendations)*

The City of Laramie and Albany County should enter into an MOA/MOU with WYDOT immediately. The MOA/MOU could be used to provide support from WYDOT for the I-80 mitigation study, help with sign placement, and ensure regular I-80 cleaning.

34. *Page 5-23. Landfills and Dumps. After last sentence in the 1st paragraph.*

The Laramie Landfill is located approximately 2 miles west of the CAPA which is considered to be a safe distance. The general groundwater flow direction is westward and any groundwater beneath the Laramie Landfill will flow away from the CAPA.

35. *Page 5-24. Sewer Line Recommendations under Design heading.*

As sewer lines are extended out to other areas of the CAPA or as existing lines are replaced, the sewer lines should be engineered in such a way as to limit the possibility of an undetected leak. Engineering techniques may include double walled pipes and regular pressure testing or other engineering techniques and leak detection systems that reduce the possibility of undetected leaks. The best technologies and engineering should be used to provide the highest level of protection. ~~lined (install double pipes). In the annular space between the lines, a leak detection system should be installed. The double lining and leak detection system will provide the necessary protection against sewer line leaks.~~

36. *Page 5-26. Under Landscaping Requirements heading*

New commercial and residential developments within the CAPA should be required are recommended to landscape using native plants, BMPs, low maintenance and low water vegetation, and xeriscape concepts. Native vegetation will reduce the amount of pesticides, herbicides, and fertilizers that need to be applied. The City and County Planning commissions should be aware of the benefits and encourage the use of native and xeriscape landscaping.

37. *Page 5-27. Under Agriculture.*

Agriculture, particularly livestock grazing, is the dominant land use within the CAPA. Agriculture zoning is the least intensive land use within Albany County. Livestock grazing is a source of potential contamination because the waste produced by the animals may enter the groundwater. Where there are uncapped wells or thin soils, there is a greater potential for wastes to enter the Casper Aquifer. High concentrations of animals also increase the risk of contamination. Particularly, commercial feedlots and confined animal feeding operations may have large amounts of waste which can enter the groundwater system and contribute to nitrate and bacteria contamination.

Agriculture Recommendations

Ordinance

It is recommended that the amended County APO Resolution and City APO Ordinance include the following provisions.

1. Prohibit commercial animal feeding operations where
 - a) animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
 - b) crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
2. Prohibit all livestock and irrigation wells that are not capped.
3. Prohibit all livestock and irrigation wells that are not cased at least to the top of the production zone with the annular space sealed from the top of the production zone to the surface.

38. *Page 5-28. Under Land Acquisition Recommendations as new heading after Purchasing heading and paragraph*

Conservation Easements and Other Land Acquisition Mechanisms

It is recommended that the City and County work towards a conservation easement program that will allow landowners to set aside a portion of their land that protects the land from development. Donation of land is another mechanism for the City and County to protect sensitive areas from development. Transferring development rights and land exchanges would also allow the City and County developmental control over specific land areas and should also be pursued as the City and County continue to protect the Casper Aquifer.

39. *Page 5-29 through 5-30. Management Goals*

Year 2008 Management Goals (Immediate Implementation)

1. The City and County should pass the amended ordinance and resolution, respectively, as provided in Appendix I.
2. Begin East Laramie/Albany County Wastewater Feasibility Study and Plan.
3. Design and implement an expanded groundwater monitoring program.
4. Pursue WYDOT MOA/MOU and obtain funding and begin I-80 mitigation study.
5. Assign a joint City/County staff person to implement the CAPP ~~by June 2008.~~
6. Retain a consultant or qualified staff to review site-specific investigations and development plans within the CAPA.
- ~~7. Begin inspecting existing septic systems through the Water and Wastewater Engineer staff position and repeat inspections every three years.~~

- ~~8. Conduct a table-top emergency response drill using a hazardous material spill on I-80 as the scenario. In 2009, a full-scale exercise using a similar scenario should be conducted.~~
- ~~9. Retain a consultant to review site-specific investigations and development plans within the CAPA.~~
- ~~10. Purchase Zone 1 property.~~

Year 2009 Management Goals (within 1 year) (note: these have just been moved from immediate to within 1 year but are not new goals)

- 1. Begin inspecting existing septic systems through the Water and Wastewater Engineer staff position and repeat inspections every three years.
- 2. Conduct a table-top emergency response drill using a hazardous material spill on I-80 as the scenario. In 2009, a full-scale exercise using a similar scenario should be conducted.
- 3. Purchase and annex Zone 1 property.

Year 2010 Management Goals (add these goals to already existing goals specified in January draft)

- 1. Work with WYDOT to establish a regular cleaning schedule for I-80.
- 2. Become a member of the National Groundwater Foundation.

~~Year 2015 Management Goals (within 7 years)~~

- ~~1. Extend City sewer to or develop sewer districts/centralized wastewater disposal systems for areas depicted in Figure 5-1.~~

40. *Page 6-8. After last paragraph on the page and before table 6-4.*

Water deficiencies shown in Table 6-5 are based upon average and peak capacities. Pumping at peak capacities is not sustainable over the long-term. If a well(s) were inoperable due to contamination, the remaining wells are unable to pump at peak capacities beyond 40 to 50 days. Therefore, the average capacity should be considered the long-term capacity of the water systems. Over the long-term, average capacities may be unable to deliver during peak times and additional supplies may be required.

41. *Page R-2.*

Miller, L.D., and Ortiz, R. F., 2007. Ground-water quality and potential effects of individual sewage disposal system effluent on ground-water quality in Park County, Colorado, 2001-2004: U.S. Geological Survey Scientific Investigations Report 2007-5220, 48 p.

42. *Appendix F – Recommended Studies*

Groundwater Monitoring Program

The intent of the groundwater monitoring program is to establish baseline water-quality data,

monitor water-quality changes in the Casper Aquifer, and develop a database that will allow assessment of the condition of the Casper Aquifer. The program should be designed to provide a long-term systematic approach to monitoring the Casper Aquifer.

Below is a proposed scope of work for this program. The City may hire a consultant to design the monitoring program or may use this document as guidance ~~for implementing this portion of the CAPP for creating a Monitoring and Sampling Plan.~~ This is not intended to be a Monitoring and Sampling Plan. The recommendations include the key elements of a comprehensive monitoring plan and should be used to guide the development a formal Monitoring and Sampling Plan. The Plan should:

1. establish a network of measuring points for comprehensive monitoring of water levels and water quality.
2. specify procedures for constructing measuring points.
3. establish a monitoring schedule.
4. specify water-quality constituents to include in sampling.
5. specify the analytical methodologies to be used in laboratory analyses.
6. specify field protocols including: procedures for purging, sampling, decontamination, and collection of field quality assurance samples.

The monitoring program may include the following wells:

- ~~11. Existing City owned monitoring wells.~~
- ~~12. Selected existing domestic and stock wells used in Karl Taboga's research on the Casper Aquifer. These wells will reduce initial costs and provide historic information. The selected wells should be located throughout Zones 2 and 3 and include wells located near the crest of the Laramie Range.~~
- ~~13. New dedicated monitoring wells located downgradient of potential contaminant sources.—
 - a) ~~Monitoring wells downgradient of different density residential developments. For example, 1-acre lots, 35-acre lots, and 15-acre lots.—~~
 - b) ~~Two wells downgradient of mining activities.~~
 - c) ~~A monitoring well downgradient of Tumbleweed Express.~~
 - d) ~~Monitoring wells along I 80.~~
 - e) ~~A monitoring well downgradient from the Laramie Rifle Range.~~~~

~~The wells would be monitored semi-annually and would include both water level measurements and water quality samples. The water quality tests conducted would be dependent upon the potential contaminant source(s) they were intended to monitor. Following are the minimum recommended parameters for each category of land use or type of development.—~~

- ~~4. All land uses and development: total dissolved solids, conductivity, turbidity, pH, temperature, major ions (Ca, Na, Mg, Si, HCO₃, SO₄, Cl) and secondary ions (K, Fe, Sr, CO₃, NO₃, F, B)~~
- ~~5. Residential development: nitrates, total and fecal coliform, and pesticides~~
- ~~6. Mining activities: nitrates and VOCs (volatile organic compounds)~~
- ~~7. USTs: VOCs~~
- ~~8. I 80: VOCs, chlorides, and pesticides~~
- ~~9. Laramie Rifle Range: lead~~

~~10. Agriculture: nitrate~~

~~11. Other potential contaminant sources: specific to the type of potential contaminant present~~

Sampling Locations

In order to reduce costs the City should use existing wells where possible. However, there will be areas where additional monitoring wells will be required. The map (Figure F-1) shows the proposed locations of all monitoring wells. The exact locations may need to be moved due to access restrictions.

Following is a description of the existing monitoring wells and additional areas that are recommended to be monitored (Table 1). In general monitoring locations are placed along the one (1) year time-of-travel as modeled by Western Water Consultants (1993) and where access is available. Two monitoring wells are downgradient of limestone quarries. Three monitoring wells are downgradient of subdivisions. Three monitoring wells are along I-80. The monitoring wells that are downgradient of specific potential contaminant sources (quarries, subdivisions, and I-80) will allow long-term monitoring of these activities while the other wells will allow more general long-term monitoring of the aquifer.

1. Existing City-owned monitoring wells.
 - a) Soldier MW-5
 - a) Spur MW-12
2. Other existing monitoring wells.
 - a) TW-1, Wyoming Water Development Comm. (permit no. P95556W, FID 85548)
 - b) Huntoon #2, Wyoming Water Resources Research Institution (permit no. P44232W, FID 35392).
3. New dedicated monitoring wells.
 - a) Monitoring wells along the 1 year time-of-travel boundary have the following names in Figure F-1: Turner MW-1, Turner MW-2, Turner MW-3, Turner MW-4, Turner MW-5, Pope-Solider MW-1, Pope-Solider MW-2, and Simpson MW-1. The wells along the 1 year time-of-travel boundary are intended to be sentinel wells which will be used to collect long-term data, provide an early warning if contamination occurred, and allow the City Utility to conduct additional sampling if water-quality was degraded compared to historical data.
 - b) Monitoring wells downgradient of different density residential developments. Figure F-1 depicts the new monitoring well Turner MW-6. The monitoring wells below residential development will allow long-term monitoring of the aquifer and data to help determine the impact of residential land use on the aquifer.
 - c) Two wells downgradient of existing mining activities. These two wells should be installed by Mountain Cement but should be maintained and monitored by the City. Figure F-1 shows these wells as MC-3 and MC-4. The monitoring wells below mining operation will allow determination of the impacts, if any, of limestone mining on the aquifer.
 - d) Monitoring wells along I-80.
 - e) These wells are named I80 MW-1, I80 MW-2, and I80 MW-3 in Figure F-1. The monitoring wells placed along I-80 can be used, in addition to long-term monitoring, as wells which would be sampled if a hazardous material spill occurred on I-80. The City should work with WYDOT to see if funding is available for installing, maintaining, and monitoring these wells through WYDOT offices.

Table 1: Monitoring wells for the groundwater monitoring program.

<u>Purpose</u>	<u>Existing wells</u>	<u>Proposed wells</u>
<u>General (1 year time-of travel) monitoring</u>	<u>Soldier MW-5</u> <u>Spur MW-12</u>	<u>Simpson MW-1</u> <u>Pope-Solider MW-1</u> <u>Pope-Solider MW-2</u> <u>Turner MW-1</u> <u>Turner MW-2</u> <u>Turner MW-3</u> <u>Turner MW-4</u> <u>Turner MW-5</u>
<u>I-80 monitoring</u>	<u>None</u>	<u>I80 MW-1</u> <u>I80 MW-2</u> <u>I80 MW-3</u>
<u>Residential development monitoring</u>	<u>TW-1</u> <u>Huntoon #2</u>	<u>Turner MW-6</u>
<u>Quarry monitoring</u>	<u>None</u>	<u>MC-3</u> <u>MC-4</u>

Sampling Parameters and Frequency

The wells will be monitored, at a minimum, quarterly and would include both water level measurements and water-quality samples. It is recommended that the contaminants listed in the National Primary Drinking Water Standards and National Secondary Drinking Water Standards be monitored for all wells on a yearly basis (appended to the end of Appendix F). The quarterly sampling should include all inorganic compounds and microorganisms on the National Primary and Secondary Drinking Water Standards, petroleum hydrocarbons, conductivity, and temperature. The petroleum hydrocarbons will be used as a surrogate for organic compounds. If a petroleum hydrocarbon is detected, the City should initiate additional organic parameter testing at the impacted well.