The Part I wellhead protection plan includes the vulnerability assessments for the city of Oronoco's wells and DWSMA. These vulnerability assessments are used to help define potential contamination sources within the DWSMA and select appropriate measures for reducing the risk that they present to the public water supply.

Water quality information is diagnostic of the vulnerability of groundwater to contamination from surface land uses. All available information regarding the quality of water was assessed for this purpose, Table 6.

Table 1 - Water Quality Results

Well	Date	Tritium (TU)	Nitrate (mg/L)	Chloride/Bromide ratio	Chloride (mg/L)	Bromide (mg/L)
Well #1 (676676)	**6/6/2011**	**1.6**	--	--	--	--
Well #1 (676676)	**7/16/2013**	--	--	**168**	**1.92**	**0.0144**
Well #1 (676676)	**5/19/2015**	--	**0.92**	--	--	--
Well #2 (733086)	**1/24/2006**	--	**0.24**	--	--	--

Assessment of Well Vulnerability

The vulnerability to contamination of for the wells used 2by the city of Oronoco, Table 1, is considered to be high. This assessment is based upon the following conditions:

1) Well construction meets current State Well Code specifications (Minnesota Rules, part 4725), meaning that the well itself should not provide a pathway for contaminants to enter the aquifer used by the public water supplier.
2) The geologic conditions at the well sites lack any clay-rich geologic materials over the aquifer that is sufficient to retard or prevent the vertical movement of contaminants.

None of the human-caused contaminants regulated under the federal Safe Drinking Water Act have been detected at levels indicating that the well itself serves to draw contaminants into the aquifer as a result of pumping (Alexander and Alexander, 1989).

Water samples collected from Well #1 (676676) were analyzed for tritium, nitrate-nitrogen, chloride and bromide, Table 6. The chloride concentration, < 3 mg/L, represents a background level in this aquifer; water that has not been significantly

impacted by human activities. The chloride - bromide ratio is also consistent with this interpretation, indicating that the water has not been significantly impacted by the application of road salt, sewage, or mineral fertilizer. Also, no synthetic or volatile organic chemicals have been detected.

A water sample collected from Well #2 (733086) was analyzed for nitrate-nitrogen in 2006. This well has only recently been connected to the distribution system and the historic record from this well is limited to a single sample. However, the concentration of nitrate-nitrogen at that time was the same as that found in Well #1.

Nitrate-nitrogen concentrations from samples collected from Well #1 (676676) over 10 years (Figure 9) define an upward trend; 0.93 mg/L in the most recently collected sample. Although the nitrate-nitrogen concentration is very low relative to the Federal drinking water standard of 10 mg/L; its presence confirms human impacts near the well and the need for continued monitoring on a regular basis.

The tritium concentration shows that at least a portion of the water entering Well #1 fell as precipitation within the last 40 years.

Assessment of Drinking Water Supply Management Area Vulnerability

The vulnerability of the DWSMA is high over the entire area based upon the following information:

1) Water chemistry data from wells located within the DWSMA indicate that the aquifer contains water that was recharged within the last 40 years and has detectable levels of human-caused contamination. The concentrations of nitrate-nitrogen indicate that a portion of the DWSMA is affected by surface land uses.
2) Review of the geologic logs contained in the CWI database, geological maps, and reports indicate that the aquifer exhibits a high geologic sensitivity in portions of the DWSMA where has little to no geologic protection from the direct vertical recharge of surface water. Areas of the DWSMA where geological protection exists drain to the unprotected portions.

Given the information currently available, the vulnerability of the DWSMA is uniformly high, in accordance with the Minnesota Wellhead Protection Rule (parts 4720.5100 to 4720.5590).