

APPENDIX P
DETERMINING GROUNDWATER – SURFACE WATER HYDROLOGIC CONNECTION

Two methods are provided below to determine hydrologic connection between groundwater and surface water. The first method applies to sites where the groundwater flow direction is not known via measured water elevations or published data as described in Section 2.5.1. The second method applies when the groundwater flow direction is known via measured water elevations or published data as described in Section 2.5.1.

METHOD 1 – UNKNOWN GROUNDWATER FLOW DIRECTION

To determine if a surface water is gaining from or losing to groundwater in areas where the groundwater flow direction is not known via measured water elevations or published data as described in Section 2.5.1 follow the method described here.

1. Install a groundwater piezometer adjacent to the surface water. The piezometer should be located where the middle of the groundwater mixing zone intersects the surface water (or as near as possible as approved by the reviewing authority) and approximately within 10-30 feet of the surface water (depending on accessibility). The upper end of the piezometer screen/perforated interval shall be at or above the expected high-water level in the creek adjacent to the piezometer. The lower end of the piezometer screen/perforated interval shall be at or below the elevation of the creek bed at the stilling well (step 2). For wells that are only used for monitoring, the well must meet the requirements of ARM 36.21 subchapters 1 through 8 unless the monitor well is less than 10 feet deep pursuant to ARM 36.21.802. Monitor wells less than 10 feet deep can be installed using the same methods as a test pit groundwater observation well (see department Circular DEQ-4, Appendix C).
2. Install one stilling well (typically pvc or metal pipe) in the surface water. The stilling well should be located downstream, at least 3 times the distance from the piezometer to the surface water. For example, if the piezometer is located 15 feet from the surface water the stilling well should be located at least 45 feet downstream from the piezometer in a straight line (not measured along the stream meanders). The exact location can be modified as approved by the reviewing authority to account for large stream bends/sinuosity or other unusual site conditions. The stilling well is required to be located downstream of the piezometer because the direction of ground water flow is unknown. In situations where the groundwater flow is not perpendicular to the surface water (and flows in a downstream direction which is common) the downstream stilling well is necessary to determine if the surface water is gaining from the groundwater. If a stilling well cannot be installed safely in the required location an alternate location may be proposed as approved by the reviewing authority. If a stilling well cannot be installed safely in the required location an alternate location may be proposed as approved by the reviewing authority.
3. Survey the elevations of the measuring point of the stilling well and the piezometer relative to each other to the nearest 0.01 feet.
4. Measure the depth to water in the piezometer and stilling well on a weekly basis during July, August and September when using the 14Q5 for dilution. Depth to water measurements shall be to the nearest 0.01 foot. Convert the depths to water to elevations using the surveyed elevation data.

5. The water elevation in the piezometer and stilling well will demonstrate whether groundwater is entering the surface water or whether the surface water is losing water to groundwater:
 - a. If the surface water is gaining from groundwater (i.e. water elevation in the piezometer is higher than the stilling well) during any single measurement, then impacts to the surface water must be assessed.
 - b. If the surface water is losing to groundwater (i.e. water elevation in the piezometer is lower than or equal to the stilling well) for all measurements, then assessing impacts to that surface water is not required.

METHOD 2 – KNOWN GROUNDWATER FLOW DIRECTION

To determine if a surface water is gaining from or losing to groundwater in areas where the groundwater flow direction is known via measured water elevations or published data as described in Section 2.5.1 follow the method described here.

1. Install a groundwater piezometer adjacent to the surface water. The piezometer should be located where the middle of the groundwater mixing zone intersects the surface water (or as near as possible as approved by the reviewing authority) and approximately within 10-30 feet of the surface water (depending on accessibility). The upper end of the piezometer screen/perforated interval shall be at or above the expected high-water level in the surface water adjacent to the piezometer. The lower end of the piezometer screen/perforated interval shall be at or below the elevation of the surface water bed at the stilling well (step 2). For wells that are only used for monitoring, the well must meet the requirements of ARM 36.21 subchapters 1 through 8 unless the monitor well is less than 10 feet deep pursuant to ARM 36.21.802. Monitor wells less than 10 feet deep can be installed using the same methods as a test pit groundwater observation well (see department Circular DEQ-4, Appendix C).
2. Install a stilling well (typically pvc or metal pipe) in the stream. The stilling well shall be installed directly downgradient, based on the known groundwater flow direction, of the piezometer. If a stilling well cannot be installed safely in the required location an alternate location may be proposed as approved by the reviewing authority.
3. Survey the elevations of the measuring point of the stilling well and the piezometer relative to each other to the nearest 0.01 feet.
4. Measure the depth to water in piezometer and stilling well on a weekly basis during July, August and September when using the 14Q5 for dilution. Depth to water measurements shall be to the nearest 0.01 feet. Convert the depths to water to elevations using the surveyed elevation data.
5. The water elevations in the piezometer and stilling well will demonstrate whether groundwater is entering the surface water or whether the surface water is losing water to groundwater:
 - a. If the surface water is gaining from groundwater (i.e. water elevation in the piezometer is higher than the stilling well) during any single measurement, then impacts to the surface water must be assessed.
 - b. If the surface water is losing to groundwater (i.e. water elevation in the piezometer is lower than or equal to the stilling well) for all measurements, then assessing impacts to that surface water is not required.