Aquifer Classification Codes and Descriptions

Online Supplemental Summary Tables from Classification of Aquifers (Payne 2010)

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Table 1. METRIC summary of aquifer classification codes and descriptions. Numeric classes, special conditions, and narrative descriptions are described in Payne (2010). See the tables referenced in the left column in parentheses below.
Notes: m = meters, min = minutes, d = day, l = liters, T = transmissivity, K = hydraulic conductivity, Spc = specific capacity, and *u*s/cm = microsiemens per cm at 25 degrees C.

Geologic framework (4)	Alluvium (A_x), colluvium (C_x), alluvial fan (A_{fx}), fluvial plain meandering (F_{pm}), fluvial plain braided (F_{pb}), fluvial plain older terrace (F_{pt}), volcanic unconsolidated (V_u), glacial till (G_t), glacial outwash (G_o), glacial moraine (G_m), lacustrian/playa (L), eolian (E_x), debris flow / landslide (D_{fx}), bedrock (B_x), undifferentiated (U_x)			
Flow class potential (5) narrative and (6) numeric classification	(Class A) high flow: >58 l/min/m Spc, >76 m^2/d T, >2,300 m/d K (A-, A, A+, A++)	(Class B) intermediate flow: < Class A and > Class C (B-, B, B+)	(Class C) low flow: <0.6 l/min/m Spc, <23 m^2/d T, <0.8 m/d K (C-, C, C+)	(Class L_f) limited or no flow potential: <0.01 l/min/m Spc, <0.23 m^2/d T, <0.01 m/d K
Aquifer capacity vs. productivity (8)	(i) heavy: *aquifer productivity at/ near capacity*	(ii) moderate: *significant increases in water use could impact capacity*	(iii) light: *aquifer productivity is far from capacity*	
Aquifer size (8)	(a) small < 5 km^2	(b) intermediate 5-25 km^2	(c) large >25 km^2	
Hydraulic anthropogenic impacts (9)	(I_{Am}) extreme artificial recharge (>3 m water level increase over natural)	(I_A) moderate artificial recharge (>1 to 3 m water level increase over natural)	(I_D) moderate dewatering (<-2 to -20 m water level decrease over natural)	(I_{Dm}) extreme dewatering (<-20 m water level decrease over natural)
General water quality (11)	(T1) Type 1: <1,000 *u*s/cm (good)	(T2) Type 2: 1,000 - <2,500 *u*s/cm (limited)	(T3) Type 3: 2,500 - <15,000 *u*s/cm (poor)	(T4) Type 4: >15,000 *u*s/cm (very poor)
Ion chemistry (11)	(Ca, Na, Si, Mg, etc.) dominant cations	(HCO_3, SO_4, Cl, etc.) dominant anions		
Pollutants (12)	Fuel related contaminants (f), metals (m), nutrients (n), pathogen/biological (p), PCB (pcb), radiological (r), semi-volatile organic compounds (sv), volatile organic compounds (v), other organic (xo), other inorganic (xi), other biological (xb)			
Vulnerability (13)	(H) high vulnerability	(M) moderate vulnerability	(L) low vulnerability	
Depth to groundwater (14)	(vs) very shallow < 2m	(s) shallow 2 - 7m	(p) proximal >7 - 30m	(d) deep > 30m
Groundwater / surface water exchange (15)	D (Groundwater discharges to surface water, baseflow accretion as % of total surface flow) Specify (D1-100) or categorize (D25, D50, D75, D100)	R/D (Groundwater / surface water exchange is approximately neutral)	R (Surface water recharges aquifer, flow loss as % of total surface flow) Specify (R1-100) or categorize (R25, R50, R75, R100)	
Level of assessment (3)	Tier 1 (Semi-quantitative)	Tier 2 (Quantitative)	Tier 3 (Quantitative with predictive modeling)	

Table 2. ENGLISH summary of aquifer classification codes and descriptions. Numeric classes, special conditions, and narrative descriptions are described in Payne (2010). See the tables referenced in the left column in parentheses below.

Notes: ft = feet, g = gallons, min = minutes, d = day, T = transmissivity, K = hydraulic conductivity, Spc = specific capacity, mi = miles, and *u*s/cm = microsiemens per cm at 25 degrees C.

Geologic framework (4)	Alluvium (A_x), colluvium (C_x), alluvial fan (A_{fx}), fluvial plain meandering (F_{pm}), fluvial plain braided (F_{pb}), fluvial plain older terrace (F_{pt}), volcanic unconsolidated (V_u), glacial till (G_t), glacial outwash (G_o), glacial moraine (G_m), lacustrian/playa (L), eolian (E_x), debris flow / landslide (D_{fx}), bedrock (B_x), undifferentiated (U_x)			
Flow class potential (5) narrative and (7) numeric classification	(Class A) high flow: >50 gpm/ft Spc, >250,000 ft^2/d T, >250 ft/d K (A-, A, A+, A++)	(Class B) intermediate flow: < Class A and > Class C (B-, B, B+)	(Class C) low flow: <0.005 gpm/ft Spc, <250 ft^2/d T, <2.5 ft/d K (C-, C, C+)	(Class L_f) limited or no flow potential: <0.025 gpm/ft Spc, <2.5 ft^2/d T, <0.025 ft/d K
Aquifer capacity vs. productivity (8)	(i) heavy: *aquifer productivity at/ near capacity*	(ii) moderate: *significant increases in water use could impact capacity*	(iii) light: *aquifer productivity is far from capacity*	
Aquifer size (8)	(a) small < 2 mi^2	(b) intermediate 2-10 mi^2	(c) large >10 mi^2	
Hydraulic anthropogenic impacts (10)	(I_{Am}) extreme artificial recharge (>10 ft water level increase over natural)	(I_A) moderate artificial recharge (>3 to 10 ft water level increase over natural)	(I_D) moderate dewatering (<-6 to -65 ft water level decrease over natural)	(I_{Dm}) extreme dewatering (<-65 ft water level decrease over natural)
General water quality (11)	(T1) Type 1: <1,000 *u*s/cm (good)	(T2) Type 2: 1,000 - <2,500 *u*s/cm (limited)	(T3) Type 3: 2,500 - <15,000 *u*s/cm (poor)	(T4) Type 4: >15,000 *u*s/cm (very poor)
Ion chemistry (11)	(Ca, Na, Si, Mg, etc.) dominant cations	(HCO_3, SO_4, Cl, etc.) dominant anions		
Pollutants (12)	Fuel related contaminants (f), metals (m), nutrients (n), pathogen/biological (p), PCB (pcb), radiological (r), semi-volatile organic compounds (sv), volatile organic compounds (v), other organic (xo), other inorganic (xi), other biological (xb)			
Vulnerability (13)	(H) high vulnerability	(M) moderate vulnerability	(L) low vulnerability	
Depth to groundwater (14)	(vs) very shallow < 6.5 ft	(s) shallow 6.5 – 23 ft	(p) proximal >23 – 100 ft	(d) deep > 100 ft
Groundwater / surface water exchange (15)	D (Groundwater discharges to surface water, baseflow accretion as % of total surface flow) Specify (D1-100) or categorize (D25, D50, D75, D100)	R/D (Groundwater / surface water exchange is approximately neutral)	R (Surface water recharges aquifer, flow loss as % of total surface flow) Specify (R1-100) or categorize (R25, R50, R75, R100)	
Level of assessment (3)	Tier 1 (Semi-quantitative)	Tier 2 (Quantitative)	Tier 3 (Quantitative with predictive modeling)	

Table 3. A three tier assessment hierarchy for aquifer classification.

Class	Description	Data Collection Summary	Data Quality Objective
Tier 1	Semi-Quantitative	**Tier 1** assessments generally rely on available local, state, and federal data sources for groundwater classification. These assessments rely on limited new data as budgets allow and are aimed at generating large-scale aquifer classification mapping units.	Broad groundwater system analysis and aquifer classification. Results are useful for baseline analysis, limited planning, and data gap identification.
Tier 2	Quantitative	**Tier 2** assessments are quantitative hydrogeologic assessments that require characterization of groundwater and surface water resources. Tier 2 assessments use existing data and new data from monitoring wells, aquifer tests, groundwater age dating, geophysical surveys, stream flow measurements, wetland surveys, and water quality monitoring as examples.	A detailed groundwater system analysis and aquifer classification that expands baseline data. Results are useful for planning needs and characterizing groundwater issues or needs.
Tier 3	Quantitative Coupled with Predictive Modeling	**Tier 3** assessments are quantitative assessments coupled with predictive modeling. Results can be used to address specific aquifer or watershed issues. These assessments use the datasets generated from Tier 1 and Tier 2 assessments and groundwater modeling approaches. Tier 3 level analysis is typically aimed at understanding complex watershed/groundwater relationships including groundwater quality, quantity, or interaction with surface water, and end products typically support groundwater management and protection.	Tier 2 objectives and development of a predictive tool useful for comprehensive planning.

Table 4. Geological framework for aquifers associated with common sedimentary/bedrock systems of the intermontane west.

Geologic Framework/Depositional /Classification	Mapping Code
Alluvium	A_x
Colluvium	C_x
Alluvial fan	A_{fx}
Fluvial plain meandering	F_{pm}
Fluvial plain braided	F_{pb}
Fluvial plain older terrace	F_{pt}
Volcanic unconsolidated	V_u
Glacial till	G_t
Glacial outwash	G_o
Glacial moraine	G_m
Lacustrine/Playa	L
Eolian	E_x
Debris flow / Landslide	D_{fx}
Bedrock$^+$	B_x
Undifferentiated	U_x

Notes: An 'x' is included on the end of the mapping codes as an option to indicate local lithology changes. $^+$A large number of consolidated volcanic (e.g., basalt, breccia, tuff, etc.) and bedrock formations (granite, sandstone, quartzite, gneiss, etc.) are possible. Identifying the type of bedrock can be included in the classification nomenclature as an abbreviation (e.g., B_{ss} (sandstone), B_v (volcanic undifferentiated), B_{bst} (basalt), and B_{ls} (limestone)). Only competent bedrock is included in this category. Unconsolidated and semi-consolidated materials are included in the sedimentary codes.

Table 5. Narrative description and indicators for classification of high, moderate, and low production aquifers.

Class	Flow Class Potential[a]	Aquifer Flow (Q) Narrative Description Test
A	**high flow**	High flow aquifers provide water for large scale irrigation and municipal water supplies and the aquifers have little or no drawdown when stressed from pumping. Well placement for large municipal or irrigation water supplies is routine because of the availability of groundwater. These aquifers are an excellent source of domestic well water. These aquifers may also provide significant groundwater discharge to large streams and rivers.
B	**intermediate flow**	Intermediate flow aquifers provide water for irrigation and municipal water supplies. However, well placement may be challenging in order develop a desired flow rate, drawdown in production wells may be significant, exceeding more than 50 percent of the available drawdown, and wells are often carefully designed and placed to maximize well efficiency. These aquifers are usually a good source of domestic well water. These aquifers may also provide significant groundwater discharge to small and moderate size streams and rivers.
C	**low flow**	Low flow aquifers are generally not used for irrigation or municipal water supplies. These aquifers may be used for domestic groundwater supplies but locating wells may be difficult or may not achieve the desired minimum flow rate. These aquifers have limited groundwater discharge potential except for very small streams and wetlands.
L_f	**Limited or no flow**	Generally not used for any type of water supply and provide little or no groundwater discharge to surface water.

Notes:
L = aquatard
[a]Aquifer flow potential is dependent on the geometry of the aquifer as well as the hydraulic properties in Table 4A. Quantitative partitions are not proposed for this reason but described as narrative classification criteria.

Table 6. Metric units hydraulic indicators for classification of high, intermediate, and low production aquifers[q].

Class	Flow Class Potential*	SpC	K[a]	T[b]	Sy[c]	S[d]	i[e]
A	**high flow (entire range)**	**>58**	**>76**	**>2300**	**0.12 to 0.35**	**variable**	**variable**
A-	low high flow	>58 to 580	>76 to 760	>2300 to 23000			
A+	very high flow	>580 to 5800	>760 to 7600	>23000 to 230000			
A++	extremely high flow	>5800	>7600	>230000			
B	**intermediate flow (entire range)**	**0.6 to 58**	**0.8 to 76**	**23 to 2300**	**0.10 to 0.35**	**variable**	**variable**
B+	high intermediate flow	>6 to 58	>7 to 76	>230 to 2300			
B-	low intermediate flow	0.6 to 6	0.8 to 7	23 to 230			
C	**low flow (entire range)**	**<0.6 to 0.01**	**<0.8 to 0.01**	**<23 to 0.23**	**0.02 to 0.12**	**variable**	**variable**
C+	very low flow	<0.6 to 0.06	<0.8 to 0.1	<23 to 2.3			
C-	extremely low flow	<0.06 to 0.01	<0.1 to 0.01	<2.3 to 0.23			
L	**Limited or no flow**	**<0.01**	**<0.01**	**<0.23**	**<0.02**	**variable**	**variable**

Notes:
SpC = Specific capacity (liters/minute per meter of drawdown)
K = hydraulic conductivity (m/day)
T = transmissivity (m^2/day)
Sy = specific yield in unconfined aquifers
S = storage coefficient for confined and semi-confined aquifers
i = gradient
L = aquitard

[a]Supported by Bear (1972)
[b]Supported by Health (1984)
[c] Adapted from Johnson (1967) based on grain size analysis and relative hydraulic conductivity. Due to the overlap of Sy for aquifer classification, Sy alone cannot be used to partition aquifer flow potential but Sy can help partition classifications with other data, such as K and T.
[d] There is insufficient data available to partition storage (S) into high, intermediate, and low flow aquifers. In addition, the available data are highly variable. Professional judgment should be used to determine if S is commensurate with aquifer flow potential. As of gradient, this parameter is also highly variable and professional judgment should also be used to determine if gradient (i) is commensurate with aquifer flow potential.
[e] Numerical values in this table provide an indication of the potential aquifer production/yield. The ranges in this table should be compared to the narrative aquifer flow criteria in Table 3 to classify aquifers as low, intermediate, or high flow systems.

Table 7. English units hydraulic indicators for classification of high, intermediate, and low production aquifers[q].

Class	Flow Class Potential*	SpC	K[a]	T[b]	Sy[c]	S[d]	i[e]
A	**high flow (entire range)**	**>50**	**>250**	**>25000**	**0.12 to 0.35**	**variable**	**variable**
A-	low high flow	>50 to 500	>250 to 2500	>2500 to 25000			
A+	very high flow	>500 to 5000	>2500 to 25000	>25000 to 250000			
A++	extremely high flow	>5000	>25000	>250000			
B	**intermediate flow (entire range)**	**0.5 to 50**	**2.5 to 250**	**250 to 25000**	**0.10 to 0.35**	**variable**	**variable**
B+	high intermediate flow	>5 to 50	>25 to 50	>2500 to 25000			
B-	low intermediate flow	0.5 to 5	2.5 to 25	250 to 2500			
C	**low flow (entire range)**	**<0.5 to 0.01**	**<2.5 to 0.025**	**<250 to 2.5**	**0.02 to 0.12**	**variable**	**variable**
C+	very low flow	<0.5 to 0.05	<2.5 to 0.25	<250 to 25			
C-	extremely low flow	<0.05 to 0.01	<0.25 to 0.025	<25 to 2.5			
L	**Limited or no flow**	**<0.01**	**<0.025**	**<2.5**	**<0.02**	**variable**	**variable**

Notes:
SpC = Specific capacity (gpm/ft of drawdown)
K = hydraulic conductivity (ft/day)
T = transmissivity (ft^2/day)
Sy = specific yield in unconfined aquifers
S = storage coefficient for confined and semi-confined aquifers
i = gradient
L = aquitard

[a]Supported by Bear (1972)
[b]Supported by Health (1984)
[c] Adapted from Johnson (1967) based on grain size analysis and relative hydraulic conductivity. Due to the overlap of Sy for aquifer classification, Sy alone cannot be used to partition aquifer flow potential but Sy can help partition classifications with other data, such as K and T.
[d] There is insufficient data available to partition storage (S) into high, intermediate, and low flow aquifers. In addition, the available data are highly variable. Professional judgment should be used to determine if S is commensurate with aquifer flow potential. As of gradient, this parameter is also highly variable and professional judgment should also be used to determine if gradient (i) is commensurate with aquifer flow potential.
[e] Numerical values in this table provide an indication of the potential aquifer production/yield. The ranges in this table should be compared to the narrative aquifer flow criteria in Table 3 to classify aquifers as low, intermediate, or high flow systems.

Table 8. Classification of aquifer capacity vs. productivity and geographic coverage of aquifers[a].

Classification	Mapping Code	Narrative Description
Heavy	i	**At or near capacity for demand or biologic need compared to productivity**

A small or moderate groundwater development could significantly impact those already using groundwater for a water supply or there are riverine or lacustrine systems dependant on groundwater to sustain biologic resources. With additional development, there will be significant impacts to existing beneficial uses because the groundwater water supply is over-allocated and/or the connected water resources are highly sensitive to decreased groundwater discharge.

Classification	Mapping Code	Narrative Description
Moderate	ii	**Demand or biologic need is moderate compared to productivity**

A very large or several large groundwater development projects could impact those already using groundwater and/or riverine or lacustrine systems are at least partially dependant on groundwater to sustain biologic resources. With additional significant groundwater development, existing beneficial uses could be impacted because the groundwater water supply is at least partially allocated and/or the connected water resources are somewhat sensitive to decreased groundwater discharge.

Classification	Mapping Code	Narrative Description
Light	iii	**Far from capacity for demand or biologic need compared to productivity**

The groundwater system is not commonly used as a water supply or there is additional allocation possible without realizing any negative impacts on existing water users. The riverine and lacustrine systems are not dependent or have a very limited dependence on groundwater discharge. Additional groundwater development will not likely impact water users or connected ecologic systems.

Classification	Mapping Code	Relative Area
Small aquifer area	a	< 5km^2 (<2 mi^2)
Intermediate aquifer area	b	>5km^2 to 25 km^2 (>2 mi^2 to 10 mi^2)
Large aquifer area	c	>25 km^2 (>10 mi^2)

Notes: [a]Adapted from Kreye et al. (1998) and Berardinccis and Ronneseth (2002).

Table 9. Metric unit numeric and narrative classification for hydraulic anthropogenic impacts.

Map Code	Classification & Narrative	Total Water Level Change (m)[a]	Average Annual change (m/year)[b]
I_{Am}	**Extreme artificial recharge** *Long-term recharge water may create aquifers or shallow hydrostratigraphic layers that may be utilized for beneficial use.*	**>3**	**>0.1**
I_A	**Moderate artificial recharge** *A noticeable long-term increase in water level in aquifer, but the increase may not necessarily be enough to create water bearing units that can be utilized for beneficial use.*	**>1 to 3**	**>0.01 to 0.1**
None	**Unaltered/minor impacts**	**-2 to 1**	**-0.1 to 0.01**
I_D	**Moderate dewatering** *A noticeable long-term decrease in water level in aquifer but it may not necessarily be enough impact beneficial use but could if it continues.*	**<-2 to -20**	**<-0.1 to -0.6**
I_{Dm}	**Extreme dewatering** *Long-term water withdrawals are severe enough in aquifer that wells may need to be deepened in order to sustain beneficial use.*	**<-20**	**<-0.6**

Notes: [a]Productive aquifers may be located in settings where recharge is substantially less than the amount of water that can be routinely pumped for beneficial use. These aquifers are given an additional "X" classification indicating they can be or are being mined.

[b]Based on ten years of record.

Table 10. English unit numeric and narrative classification for hydraulic anthropogenic impacts.

Map Code	Classification & Narrative	Total Water Level Change (ft)[a]	Average Annual change (ft/year)[b]
I_{Am}	**Extreme artificial recharge** *Long-term recharge water may create aquifers or shallow hydrostratigraphic layers that may be utilized for beneficial use.*	**>10**	**>0.3**
I_A	**Moderate artificial recharge** *A noticeable long-term increase in water level in aquifer, but the increase may not necessarily be enough to create water bearing units that can be utilized for beneficial use.*	**>3 to 10**	**>0.03 to 0.3**
None	**Unaltered/minor impacts**	**-6.5 to 3**	**-0.3 to 0.03**
I_D	**Moderate dewatering** *A noticeable long-term decrease in water level in aquifer but it may not necessarily be enough impact beneficial use but could if it continues.*	**<-6.5 to -66**	**<-0.3 to -2**
I_{Dm}	**Extreme dewatering** *Long-term water withdrawals are severe enough in aquifer that wells may need to be deepened in order to sustain beneficial use.*	**<-66**	**<-2**

Notes: [a]Productive aquifers may be located in settings where recharge is substantially less than the amount of water that can be routinely pumped for beneficial use. These aquifers are given an additional "X" classification indicating they can be or are being mined.

[b]Based on ten years of record.

Table 11. General groundwater quality classification.

Criteria	Good *Type 1[a](T1)*	Limited *Type 2[a](T2)*	Poor *Type 3[a](T3)*	Very Poor *Type 4[a](T4)*
Specific conductance[b] (SC) (microsiemens per cm at 25° C)	<1,000 [c]	1,000 to <2,500	2,500 to 15,000	>15,000
Use as public/private water supplies	Yes[d]	Typically not useful - marginally useful according to the CWA	No if SC is > 7,000 (it is rare to use water that is >2,500)	No
Use for irrigation	Yes[d]	Yes, typically	Yes, marginally useful	No
Use for commercial and industrial uses	Yes[d]	Yes, marginally useful	Yes, marginally useful	Some
Use for wildlife/livestock/aquatic life/phreatophytes	Yes	Yes, marginally useful	Yes, marginally useful	No

Notes:

[a]Common ion chemistry and dominant anion: (Cl, HCO_3, SO_4, other) and cation: (Na & K, Ca, Mg, other) should be included with general water quality classification if sufficient water quality data are available. "$T1_{CaHCO3}$" would be an example classification for groundwater when combining the classification based on specific conductance and the dominant ion chemistry. Adapted from Freeze and Cherry (1979) and Piper et al. (1953).

[b]Adapted from the State of Montana Administrative Rules 17.30.1011. Depending on the state, substitutes for local/state required specific conductance linked to the State/Federal Clean Water Act classification criteria can be used as necessary.

[c]An "e" modifier may be used with Type 1 water quality classification if the SC is below 250 suggesting excellent water quality is present: eT1.

[d]With little or no treatment.

CWA = Clean Water Act

Table 12. Types of contaminants and classification codes.

Contaminant	Mapping Code*
Fuel related contaminants	f
Metals	m
Nutrients	n
Pathogen / biological	p
PCB	pcb
Radiological	r
Semi-volatile organic compounds	sv
Volatile organic compounds	v
Other organic	xo
Other inorganic	xi
Other biological	xb

Notes: *The contaminant classification code in this table is added to the classification criteria in Table 11 that is known to have metal, nutrient, volatile organic compounds or other contaminates above federal drinking water standards for human consumption.

Table 13. Classification of aquifers based on vulnerability to contamination.*

H (High Vulnerability): Highly vulnerable to contamination from surface sources. H aquifers have little natural protection against contamination introduced at the ground surface (e.g., shallow permeable aquifers in urban settings). Existing land uses or future additional developments, which may introduce a contaminant to the land surface, should initiate measures to protect against introducing contaminants. H aquifers should be given first priority for the implementation of quality protection measures. Often the water table is shallow or very shallow (see Table 14), hydraulic conductivity is moderate to high, and it is an unconfined setting.

M (Moderate Vulnerability): Moderately vulnerable to contamination from surface sources. M aquifers have limited natural protection against contamination introduced at the ground surface (e.g., limited low permeability layers overlying aquifers or a deeper water table compared to H aquifers in mixed land use settings). Degree of natural protection may vary across an aquifer. Existing land uses or future additional developments that could introduce a contaminant to the land surface should initiate measures to protect against introducing contaminants. M aquifers should be given priority over L aquifers when it comes to implementing quality protection measures. In proximal or deep water table (see Table 14), there is a moderate to low hydraulic conductivity, and a moderate degree of confinement where leaky conditions may be present.

L (Low Vulnerability): Generally not considered very vulnerable to contamination from surface sources. L aquifers are more protected against contamination introduced at the ground surface (extensive confining layers or very deep groundwater in rural settings). L aquifers have the lowest vulnerability rating and are the least likely to become contaminated. A rating of L does not imply that all L aquifers are immune to contamination. All aquifers are vulnerable to contamination to a certain degree, especially if there are exposed portions of the underlying aquifer or if the land-use activity breaks through the overlying confining layer. Often the water table is deep (see Table 14), the hydraulic conductivity is low and there is a high degree of confinement.

Notes: *Adapted from Kreye et al. (1998) and Berardinucci and Ronneseth (2002). Berardinucci and Ronneseth (2002) provide additional information for classifying aquifer vulnerability in terms of depth to the water table, permeability, thickness and extent of confining sediments, porosity, and land use and should be consulted for applied vulnerability assessments.

Table 14. Depth to groundwater classes for unconfined aquifers[a].

Criteria	*vs* (very shallow)	*s* (shallow)	*p* (proximal)	*d* (deep)
Metric depth to water (m)[b]	<2[c]	2 to <7[d]	7 to 30	>30
English depth to water (ft)[b]	<6.5[c]	6.5 to <23[d]	23 to 100	>100
Strong GW/SW connection	very common	fairly common	uncommon	very uncommon
Water table gradient	variable	variable	variable	variable

Notes:
[a] Confined aquifers and underlying deeper aquifers are assumed to have occasional or no direct connection to surface water. However, these aquifers may discharge to unconfined aquifers that have critical surface water connections. In settings where groundwater may be much deeper than 30 m and is considered significant for planning, classification of depth can include an indicator on the classification to approximate first groundwater is greater than a given depth (e.g., d>200).

[b] Water tables < 1 ft (0.30 m) below ground surface for more than 14 days/year are likely a wetland.

[c] High points must be maintained, on average, 14 days/year.

[d] Low point can be > 23 ft (7 m) deep during the non-growing season.

Adapted from US Army Corps of Engineers (1987), Payne and Magruder (2004), and U.S. Geological Survey (1999).

Table 15. Groundwater/surface water exchange classes for unconfined aquifers near surface water features[a].

Gaining Streams/stream reaches[b] – Percent surface water flow gained from groundwater[c]	Percent	Class
Low contribution	<25%	D25
Moderate contribution	25% - 50%	D50
High contribution	>50% - 75%	D75
Very high contribution	>75%	D100

Losing Streams/stream reaches[b] – Percent surface water flow lost to groundwater[c]	Percent	Class
Low contribution	<25%	R25
Moderate contribution	25% - 50%	R50
High contribution	>50% - 75%	R75
Very high contribution	>75%	R100

Notes:

[a]For streams / rivers with no significant loss or gain, '**R/D**' can be used to indicate steady conditions along a stream reach (e.g., no significant surface water flow loss or groundwater gain measured in study).

[b]In cases where surface water features have exchange with more than one aquifer, the classification effort should be completed for each aquifer and/or each surface water feature or stream reach (as appropriate for site specific conditions and project objectives).

[c] An actual percentage or range vs. the quartile range listed may be used with sufficient flow data and to show variability. **R** represents the percent stream flow lost along a reach to groundwater and **D** represents the percent stream flow gained along a reach from groundwater.

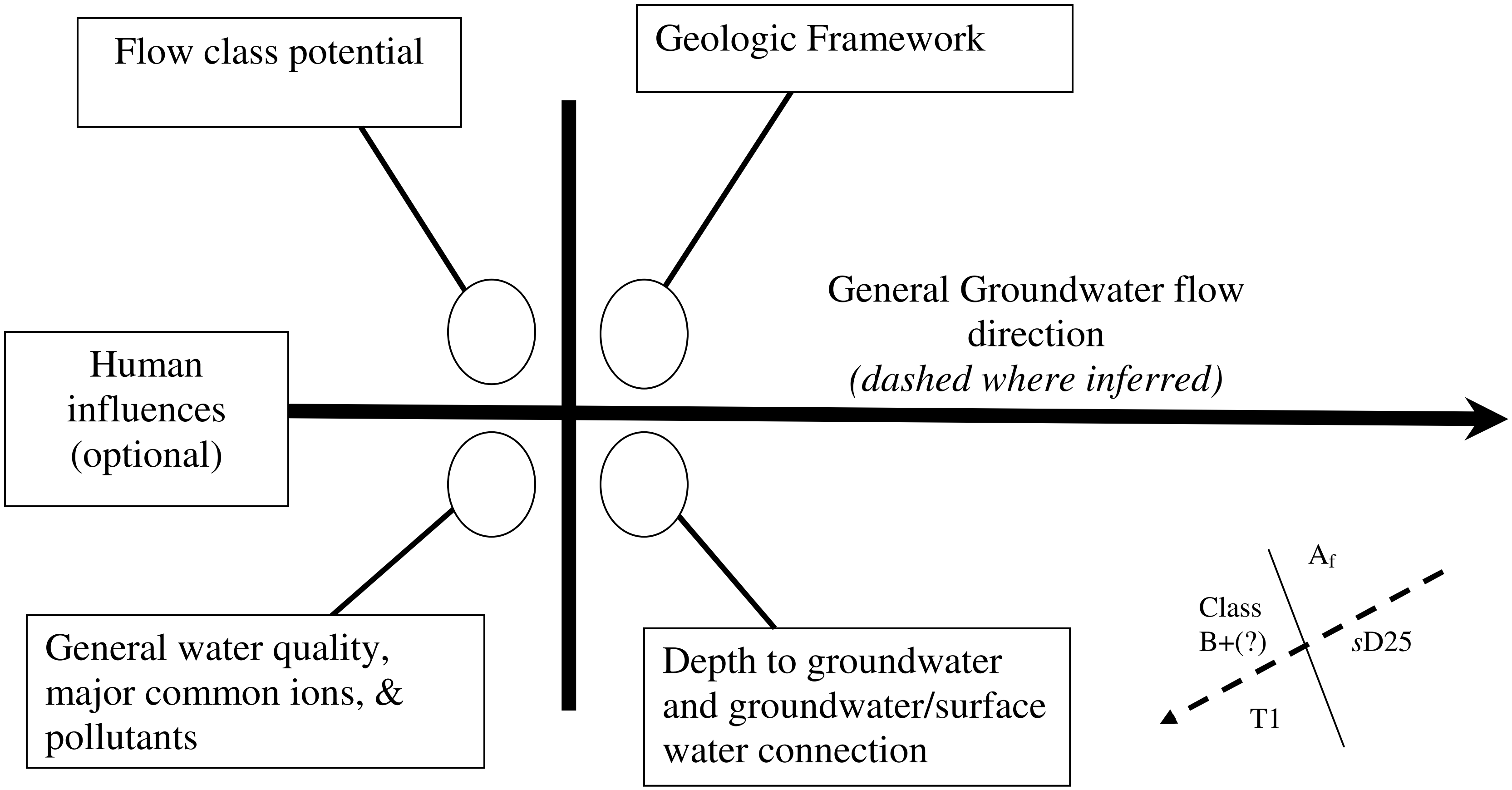

Figure 1. Aquifer classification mapping framework. The arrow and aquifer classification information is positioned on maps at specific data points or within aquifers or areas within aquifers. The arrow indicates general groundwater flow direction and coded aquifer production, geologic setting, groundwater quality and depth to groundwater positioned in the four quandrants shown above. Aquifer class should be positioned in the upper right quadrant (or left quadrant, depending on the arrow direction). The groundwater flow direction arrow rotates similar to a compass arrow with each quadrent remaining stationary. An example is shown in the lower right portion of the figure. Question marks and dashed lines are used to show inferred groundwater flow direction or limited data support classification results.

References

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