1.54. **IDENTIFY:** Area is length times width. Do unit conversions.

SET UP: 1 mi = 5280 ft. 1 ft^3 = 7.477 gal.

EXECUTE: **(a)** The area of one acre is $\frac{1}{8}\ \text{mi} \times \frac{1}{80}\ \text{mi} = \frac{1}{640}\ \text{mi}^2$, so there are 640 acres to a square mile.

(b) $(1\ \text{acre}) \times \left(\dfrac{1\ \text{mi}^2}{640\ \text{acre}}\right) \times \left(\dfrac{5280\ \text{ft}}{1\ \text{mi}}\right)^2 = 43{,}560\ \text{ft}^2$

(all of the above conversions are exact).

(c) $(1\ \text{acre-foot}) = (43{,}560\ \text{ft}^3) \times \left(\dfrac{7.477\ \text{gal}}{1\ \text{ft}^3}\right) = 3.26 \times 10^5$ gal, which is rounded to three significant figures.

EVALUATE: An acre is much larger than a square foot but less than a square mile. A volume of 1 acre-foot is much larger than a gallon.

1.86. **IDENTIFY:** If the vector from your tent to Joe's is $\vec{A}$ and from your tent to Karl's is $\vec{B}$, then the vector from Joe's tent to Karl's is $\vec{B} - \vec{A}$.

SET UP: Take your tent's position as the origin. Let $+x$ be east and $+y$ be north.

EXECUTE: The position vector for Joe's tent is

([21.0 m]cos 23°)$\hat{\boldsymbol{i}}$ -([21.0 m]sin 23°) $\hat{\boldsymbol{j}}$ = (19.33m)$\hat{\boldsymbol{i}}$ -(8.205 m) $\hat{\boldsymbol{j}}$.

The position vector for Karl's tent is ([32.0 m]cos 37°)$\hat{\boldsymbol{i}}$ + ([32.0 m]sin 37°) $\hat{\boldsymbol{j}}$ = (25.56 m)$\hat{\boldsymbol{i}}$ + (19.26 m) $\hat{\boldsymbol{j}}$.

The difference between the two positions is

(19.33 m − 25.56 m)$\hat{\boldsymbol{i}}$ + (-8.205 m -19.25 m) $\hat{\boldsymbol{j}}$ = -(6.23 m)$\hat{\boldsymbol{i}}$ -(27.46 m) $\hat{\boldsymbol{j}}$. The magnitude of this vector is the distance between the two tents: $D = \sqrt{(-6.23\ \text{m})^2 + (-27.46\ \text{m})^2} = 28.2\ \text{m}$

EVALUATE: If both tents were due east of yours, the distance between them would be $32.0\ \text{m} - 21.0\ \text{m} = 11.0\ \text{m}$. If Joe's was due north of yours and Karl's was due south of yours, then the distance between them would be $32.0\ \text{m} + 21.0\ \text{m} = 53.0\ \text{m}$. The actual distance between them lies between these limiting values.

1.99. **IDENTIFY:** Add the vector displacements of the receiver and then find the vector from the quarterback to the receiver.

SET UP: Add the *x*-components and the *y*-components.

EXECUTE: The receiver's position is

[(+1.0 + 9.0 -6.0 +12.0)yd]$\hat{\boldsymbol{i}}$ + [(-5.0 +11.0 + 4.0 +18.0) yd] $\hat{\boldsymbol{j}}$ = (16.0 yd)$\hat{\boldsymbol{i}}$ + (28.0 yd) $\hat{\boldsymbol{j}}$.

The vector from the quarterback to the receiver is the receiver's position minus the quarterback's position, or (16.0 yd)$\hat{\boldsymbol{i}}$ + (35.0 yd) $\hat{\boldsymbol{j}}$, a vector with magnitude $\sqrt{(16.0\ \text{yd})^2 + (35.0\ \text{yd})^2} = 38.5$ yd.

The angle is $\arctan\left(\dfrac{16.0}{35.0}\right) = 24.6°$ to the right of downfield.

EVALUATE: The vector from the quarterback to receiver has positive *x*-component and positive *y*-component.