$\boxed{1}$ Yes.

$A = QR \rightsquigarrow A^*A = R^*Q^*QR.$

Note that Q is unitary matrix in the QR factorization. So, $A^*A = R^*R$.

R is an upper triangular. And, $r_{jj} > 0$ for $\forall 1 \le j \le m$ (let A is $m \times m$ as we assumed).

So, it is a Cholesky Factorization of A^*A, and we can see that A^*A is hermitian positive definite since A is nonsingular

$\because$ Hermitian clearly : $(A^*A)^* = A^*A$

And, for $\forall x \neq 0 \in \mathbb{C}^m$, we know that $Ax \neq 0$ since A is nonsingular.
Then, $x^*(A^*A)x = (Ax)^*(Ax) > 0$. So, it is also positive definite

So, by Thm 23.1, Hermitian positive definite A^*A has a unique Cholesky factorization

$\therefore R = L$ //

$\boxed{2}$ $Ax = b \rightsquigarrow$

$A = R^*R$ Factor A into R^*R ①

$R^*y = b$ Forward Substitution ②

$y = Rx$ Backward Substitution ③

① By Thm 23.2, $\tilde{R}^*\tilde{R} = A + \delta A$ with some $\|\delta A\|/\|A\| = O(\varepsilon_{machine})$

② By Thm 17.1, $(\tilde{R}^* + \delta R_1^*)\tilde{y} = b$ with $\|\delta R_1^*\|/\|\tilde{R}^*\| = O(\varepsilon_{machine})$

③ 〃 $(\tilde{R} + \delta R_2)\tilde{x} = \tilde{y}$ with $\|\delta R_2\|/\|\tilde{R}\| = O(\varepsilon_{machine})$

By Thm 14.1, we can say that $\|\tilde{R}\| = \|\tilde{R}^*\| = \|A + \delta A\|^{1/2}$ (results from 2-norm)

$$\frac{\|\tilde{R}\|}{\|A\|} = \frac{\|A+\delta A\|^{1/2}}{\|A\|} = \frac{\|A+\delta A\|}{\|A\|\,\|\tilde{R}^*\|} = O\left(\frac{1}{\|\tilde{R}^*\|}\right) \text{ as } \varepsilon_{machine} \to 0 \quad \left(\text{Analogous for } \frac{\|\tilde{R}^*\|}{\|A\|}\right)$$

Composing these,

$$b = (\tilde{R}^* + \delta R_1^*)(\tilde{R} + \delta R_2)x = (\underbrace{A + \delta A + \tilde{R}^*\delta R_2 + \delta R_1^*\tilde{R} + \delta R_1^*\delta R_2}_{\Delta A.})x$$

$$\frac{\|\tilde{R}^*\delta R_2\|}{\|A\|} \le \frac{\|\tilde{R}^*\|}{\|A\|}\|\delta R_2\| = O\left(\frac{\|\delta R_2\|}{\|\tilde{R}\|}\right) = O(\varepsilon_{machine})$$

$$\frac{\|\delta R_1^* \cdot \delta R_2\|}{\|A\|} \le \frac{\|\delta R_1^*\|\,\|\delta R_2\|}{\|A\|} = \frac{\|\tilde{R}\|\,\|\tilde{R}^*\|}{\|A\|}\,\frac{\|\delta R_1^*\|\,\|\delta R_2\|}{\|\tilde{R}\|\,\|\tilde{R}^*\|} = O(1) \cdot O(\varepsilon_{machine}^2)$$

$$\therefore \frac{\|\Delta A\|}{\|A\|} \le \frac{\|\delta A + \tilde{R}^*\delta R_2 + \delta R_1^*\tilde{R} + \delta R_1^*\delta R_2\|}{\|A\|} = O(\varepsilon_{machine}) \blacksquare$$