Very detailed calculation of the laplacian of a Plummer potential.
The laplacian:

$$\nabla^2\phi = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial\phi}{\partial r}\right)$$

The first derivative:

$$\begin{aligned}\frac{\partial\phi}{\partial r} &= -\frac{\partial}{\partial r}\left(\frac{GM}{\sqrt{b^2+r^2}}\right)\\ &= \frac{1}{2}\frac{GM}{(b^2+r^2)^{3/2}}(2r)\\ &= \frac{GMr}{(b^2+r^2)^{3/2}}\end{aligned}$$

The second derivative:

$$\begin{aligned}\frac{\partial}{\partial r}\left(r^2\frac{\partial\phi}{\partial r}\right) &= \frac{\partial}{\partial r}\left(\frac{GMr^3}{(b^2+r^2)^{3/2}}\right)\\ &= GM\frac{3r^2(b^2+r^2)^{3/2} - 3r^4(b^2+r^2)^{1/2}}{(b^2+r^2)^3}\\ &= GM\frac{(b^2+r^2)^{1/2}}{(b^2+r^2)^3}\left(3r^2(b^2+r^2) - 3r^4\right)\\ &= GM\frac{1}{(b^2+r^2)^{5/2}}\left(3r^2(b^2+r^2-r^2)\right)\\ &= \frac{3GMr^2b^2}{(b^2+r^2)^{5/2}}\end{aligned}$$

The laplacian:

$$\nabla^2\phi = \frac{3GMb^2}{(b^2+r^2)^{5/2}}$$