$$\ln \hat{\phi}_1 = \int_0^P (\bar{Z}_1 - 1)\frac{dP}{P} = \int_0^P \left[(1-y_2^2)B_{11} - y_2^2 B_{22} + 2y_2^2 B_{12}\right]\frac{P}{RT}\frac{dP}{P}$$

$$= \left[(1-y_2^2)B_{11} - y_2^2 B_{22} + 2y_2^2 B_{12}\right]\frac{1}{RT}\int_0^P dP$$

$$\ln \hat{\phi}_1 = \left[(1-y_2^2)B_{11} - y_2^2 B_{22} + 2y_2^2 B_{12}\right]\frac{P}{RT}$$

$$\ln \hat{\phi}_2 = \left[(1-y_1^2)B_{22} - y_1^2 B_{11} + 2y_1^2 B_{12}\right]\frac{P}{RT}$$