CLAIMS

1. A composition comprising: hydrogen peroxide; and stable free available chlorine.

~~2. The composition according to claim 1, wherein the amount of hydrogen peroxide is about 10 ppm to 500 ppm.~~

~~3. The composition according to claim 2, wherein the hydrogen peroxide is present in an amount of about 25 ppm to 300 ppm .~~

~~4. The composition according to claim 3, wherein the hydrogen peroxide is present in an amount of about 50 ppm to 200 ppm.~~

~~5. The composition according to claim 4, wherein the hydrogen peroxide is present in an amount of about 100 ppm to 150 ppm.~~

~~6. The composition according to claim 1, wherein the hydrogen peroxide is present in an amount of at most 300 ppm.~~

~~7~~2. The composition according to ~~any one of claims 1-6~~claim 1, wherein the amount of the stable free available chlorine is about 10 ppm to 500 ppm

~~8. The composition according to claim 7, wherein the stable free available chlorine is present in an amount of 25 ppm to 300 ppm.~~

~~9. The composition according to claim 8, wherein the stable free available chlorine is present in an amount of 50 ppm to 200 ppm.~~

~~10. The composition according to claim 9, wherein the stable free available chlorine is present in an amount of 100 ppm to 150 ppm.~~

~~11~~3. The composition according to claim 1~~any one of claims 1-6~~, wherein the amount of the stable free available chlorine is ~~present in an amount of~~ at ~~most 300 ppm~~least 10 ppm to at most 1,000 ppm.

~~124~~. The composition according to claim ~~11~~1 or 3, wherein the amount of the stable free available chlorine is ~~present in an amount of~~ at least 50 ppm to at most ~~150~~ 700 ppm.

~~135~~. The composition according to any one of claims 1-~~124~~, wherein the stable free available chlorine includes hypochlorous acid, hypochlorite (OCl^-), chlorine gas (Cl_2), superchloride (Cl_2^-), chlorine oxide radicial (ClO), peroxyhypochlorous acid (HOOCl), another reactive chlorine species (RCS), or a combination thereof.

~~146~~. The composition of any one of claims 1-~~135~~, further comprising a reactive oxygen species (ROS).

~~157~~. The composition of claim ~~146~~, wherein the reactive oxygen species includes oxygen gas (O_2), superoxide (O_2^-), singlet oxygen ($^1O_2$), α-oxygen (α-O), protonated oxygen (HO_2^+), hydroperoxyl radical (HO_2), hydroxyl radical (OH), peroxide (O_2^{-2}), ozone (O_3), ozonide (O_3^-), or a combination thereof.

~~168~~. The composition according to any one of claims 1-~~15~~ 7 further comprising~~, consisting essentially of, or consisting of~~ one or more metallic particles or one or more metal salts.

~~179~~. The composition according to Claim ~~168~~, wherein the one or more metal particles or one or more metal salts are present in an amount of 10 ppm to 300 ppm.

~~1810~~. The composition according to Claim ~~179~~, wherein the one or more metal particles or one or more metal salts are present in an amount of 20 ppm to 200 ppm.

~~1911~~. The composition according to Claim ~~1810~~, wherein the one or more metal particles or one or more metal salts are present in an amount of 30 ppm to 100 ppm.

~~2012~~. The composition according to any one of claims ~~16-19~~8-11, wherein the one or more metal particles or one or more metal salts comprise copper, iron, silver, titanium or zinc or any mixture thereof.

~~21. The composition according to any one of claims 16-20, wherein the one or more metal particles include a metal acetate particle, a metal chloride particle, a metal nitrate particle, a metal oxide particle, or any combination thereof.~~

~~22. The composition according to Claim 21, wherein the metal chloride particle includes copper chloride, iron chloride, silver chloride, titanium chloride, zinc chloride, or any combination thereof.~~

~~23~~13. The composition according to any one of claims 8-12 ~~Claim 21~~, wherein the one or more metal particles comprise metal oxide particles ~~includes~~ including calcium oxide, copper oxide, iron oxide, silver oxide, titanium dioxide, zinc oxide, copper zinc iron oxide, or any combination thereof.

~~24~~14. The composition to any one of claims ~~16-23~~8-13, wherein the one or more metal salts include a metal acetate, a metal chloride, a metal nitrate, a metal sulfate, or any combination thereof.

~~25~~15. The composition according to Claim ~~24~~14, wherein the metal acetate includes copper acetate, iron acetate, potassium acetate, silver acetate, titanium acetate, or zinc acetate.

~~26~~16. The composition according to Claim ~~24~~15, wherein the metal chloride includes copper chloride, iron (II) chloride, iron (III) chloride, potassium chloride, silver chloride, titanium chloride, or zinc chloride.

~~27~~17. The composition according to Claim ~~24~~14, wherein the metal nitrate includes copper nitrate, iron nitrate, potassium nitrate, silver nitrate, titanium nitrate, or zinc nitrate.

~~28~~18. The composition according to Claim ~~24~~14, wherein the metal sulfate includes copper sulfate, iron sulfate, potassium sulfate, silver sulfate, titanium sulfate, or zinc sulfate.

2919. The composition according to Claim 2313, wherein the one or more metal oxide particles comprises calcium oxide is obtained from an organic source.

30. The composition according to Claim 29, wherein the organic source includes shells from oceanic organisms.

3120. A composition comprising: about 0.1 ppm to about 1,000 ppm of one or more peroxides; and stable free available chlorine.

32. The composition according to claim 31, wherein the amount of the one or more peroxides is about 1 ppm to about 500 ppm by weight of the composition.

33. The composition according to claim 32, wherein the amount of the one or more peroxides is about 10 ppm to about 250 ppm by weight of the composition.

3421. The composition according to claim 20 any one of claims 31-33, wherein the amount of the stable free available chlorine is about 10 ppm to 500 ppm

35. The composition according to claim 34, wherein the stable free available chlorine is present in an amount of 25 ppm to 400 ppm.

36. The composition according to claim 35, wherein the stable free available chlorine is present in an amount of 50 ppm to 350 ppm.

37. The composition according to claim 36, wherein the stable free available chlorine is present in an amount of 75 ppm to 250 ppm.

3822. The composition according to any one of claims 31-36claim 20, wherein the amount of the stable free available chlorine is present in an amount of at most 300 ppmleast 10 ppm to at most 1,000 ppm.

~~39~~23. The composition according to claim ~~38~~20 or 22, wherein the amount of the stable free available chlorine is ~~present in an amount of~~ at least 50 ppm to at most ~~250~~ 700 ppm.

~~40~~24. The composition according to any one of claims ~~31-39~~20-23, wherein the one or more peroxides include hydrogen peroxide, sodium peroxide, calcium peroxide, lithium peroxide, potassium peroxide, other alkali metal peroxides, other alkali earth metal peroxides, or a combination thereof.

~~41~~25. The composition according to any one of claims ~~31-40~~20-24, wherein the stable free available chlorine includes hypochlorous acid, hypochlorite (OCl^-), chlorine gas (Cl_2), superchloride (Cl_2^-), chlorine oxide radical (ClO), peroxyhypochlorous acid (HOOCl), another reactive chlorine species (RCS), or a combination thereof.

~~42~~26. A method of making a composition according to any one of Claims ~~31-41~~1-25, the method composting hydrolyzing a solution comprising sodium hydroxide, phosphate, and sodium peroxide in the presence of chloride gas.

~~43. The method according to Claim 42, wherein the amount of the sodium peroxide added to the solution is at least 50 ppm.~~

~~44. The composition of any one of claims 31-43, further comprising a reactive oxygen species (ROS).~~

~~45. The composition of claim 44, wherein the reactive oxygen species includes oxygen gas (O_2), superoxide (O_2^-), singlet oxygen ($^1O_2$), α-oxygen (α-O), protonated oxygen (HO_2^+), hydroperoxyl radical (HO_2), hydroxyl radical (OH), peroxide (O_2^{-2}), ozone (O_3), ozonide (O_3^-), or a combination thereof.~~

~~46~~27. Sodium peroxide for use in the manufacture of a composition according to any one of Claims ~~31-39~~20-25.

~~47. The use according to Claim 46, wherein the amount of the sodium peroxide used is at least 50 ppm.~~

~~48~~28. A method of producing a solution stably comprising one or more free available chlorine species and one or more peroxides, the method comprising

preparing a first solution comprising purified water and an appropriate trace amount of one or more peroxides;

introducing chlorine gas to the first solution for a first period of time to produce a first reaction solution;

adding an appropriate trace amount of one or more peroxides the first reaction solution; and

introducing chlorine gas to the first reaction solution for a second period of time to produce a second reaction solution,

wherein the resulting second reaction solution has higher levels of one or more free available chlorine species and one or more peroxides as compared to the first reaction solution.

~~49~~29. The method according to claim ~~48~~28, wherein the first reaction solution comprises approximately equimolar amounts of one or more free available chlorine species and one or more peroxide species and has a pH below 4.

~~50~~30. The method according to claim ~~48~~ 28 or ~~49~~29, wherein the second reaction solution comprises approximately equimolar amounts of one or more free available chlorine species and one or more peroxide species and has a pH below 4.

~~51~~31. The method according to any one of claims ~~48-50~~28-30, wherein the appropriate amount of one or more peroxides in a first solution is about 0.01% to about 0.15%, about 0.02% to about 0.12%, about 0.03% to about 0.11%, about 0.04% to about 0.10%, about 0.05% to about 0.09%, or about 0.06% to about 0.08% by weight of the first solution.

~~52~~32. The method according to any one of claims ~~48-51~~28-31, wherein the appropriate amount of one or more peroxides in a first reaction solution is about 0.001% to about 0.01%, about 0.001% to about 0.0125%, about 0.001% to about 0.015%, about 0.001% to about 0.0175%, about 0.001% to about 0.02%, about 0.001% to about 0.03%, about 0.001% to about 0.04%, about 0.0025% to about 0.01%, about 0.0025% to about 0.0125%, about 0.0025% to about 0.015%, about 0.0025% to about 0.0175%, about 0.0025% to about 0.02%, about 0.0025% to about 0.03%, about 0.0025% to about 0.04%, about 0.005% to about 0.01%, about 0.005% to about 0.0125%, about 0.005% to about 0.015%, about 0.005% to about 0.0175%, about 0.005% to about 0.02%, about 0.005% to about 0.03%, about 0.005% to about 0.04%, about 0.0075% to about 0.01%, about 0.0075% to about 0.0125%, about 0.0075% to about 0.015%, about 0.0075% to about 0.0175%, about 0.0075% to about 0.02%, about 0.0075% to about 0.03%, about 0.0075% to about 0.04%, about 0.01% to about 0.0125%, about 0.01% to about 0.015%, about 0.01% to about 0.0175%, about 0.01% to about 0.02%, about 0.01% to about 0.03%, or about 0.01% to about 0.04% by weight of the first reaction solution.

~~53~~33. The method according to any one of claims ~~48-52~~28-32, wherein the first period of time is longer in duration than the second period of time.

~~54~~34. The method according to any one of claims ~~48-53~~28-33, wherein the first period of time is about 30 minutes to about 40 minutes, about 30 minutes to about 45 minutes, about 30 minutes to about 50 minutes, about 30 minutes to about 55 minutes, or about 30 minutes to about 60 minutes.

~~55~~35. The method according to any one of claims ~~48-54~~28-34, wherein the second period of time is about 5 minutes to about 10 minutes, about 5 minutes to about 15 minutes, about 5 minutes to about 20 minutes, about 5 minutes to about 30 minutes, about 10 minutes to about 15 minutes, about 10 minutes to about 20 minutes, about 10 minutes to about 30 minutes, about 15 minutes to about 20 minutes, about 15 minutes to about 30 minutes, or about 20 minutes to about 30 minutes.

~~55~~36. The method according to any one of claims ~~48-54~~28-35, further comprising

adding an appropriate trace amount of one or more peroxides the second reaction solution; and

introducing chlorine gas to the second reaction solution for a third period of time to produce a third reaction solution,

wherein the resulting third reaction solution has higher levels of one or more free available chlorine species and one or more peroxides as compared to the second reaction solution.

~~56~~37. The method according to claim ~~55~~36, wherein the appropriate amount of one or more peroxides in a second reaction solution is about 0.001% to about 0.01%, about 0.001% to about 0.0125%, about 0.001% to about 0.015%, about 0.001% to about 0.0175%, about 0.001% to about 0.02%, about 0.001% to about 0.03%, about 0.001% to about 0.04%, about 0.0025% to about 0.01%, about 0.0025% to about 0.0125%, about 0.0025% to about 0.015%, about 0.0025% to about 0.0175%, about 0.0025% to about 0.02%, about 0.0025% to about 0.03%, about 0.0025% to about 0.04%, about 0.005% to about 0.01%, about 0.005% to about 0.0125%, about 0.005% to about 0.015%, about 0.005% to about 0.0175%, about 0.005% to about 0.02%, about 0.005% to about 0.03%, about 0.005% to about 0.04%, about 0.0075% to about 0.01%, about 0.0075% to about 0.0125%, about 0.0075% to about 0.015%, about 0.0075% to about 0.0175%, about 0.0075% to about 0.02%, about 0.0075% to about 0.03%, about 0.0075% to about 0.04%, about 0.01% to about 0.0125%, about 0.01% to about 0.015%, about 0.01% to about 0.0175%, about 0.01% to about 0.02%, about 0.01% to about 0.03%, or about 0.01% to about 0.04% by weight of the first reaction solution.

~~57~~38. The method according to claim ~~55-~~36 or ~~56~~37, wherein the second period of time is longer in duration than the third period of time.

~~58~~39. The method according to any one of claims ~~55-57~~36-38, wherein the third period of time is about 5 minutes to about 10 minutes, about 5 minutes to about 15 minutes, about 5 minutes to about 20 minutes, about 5 minutes to about 30 minutes, about 10 minutes to about 15 minutes, about 10 minutes to about 20 minutes, about 10 minutes to about 30 minutes, about

15 minutes to about 20 minutes, about 15 minutes to about 30 minutes, or about 20 minutes to about 30 minutes.

5940. The method according to any one of claims 55-5836-39, further comprising

adding an appropriate trace amount of one or more peroxides the third reaction solution; and

introducing chlorine gas to the third reaction solution for a fourth period of time to produce a fourth reaction solution,

wherein the resulting fourth reaction solution has higher levels of one or more free available chlorine species and one or more peroxides as compared to the third reaction solution.

6041. The method according to claim 5940, wherein the appropriate amount of one or more peroxides in a third reaction solution is about 0.001% to about 0.01%, about 0.001% to about 0.0125%, about 0.001% to about 0.015%, about 0.001% to about 0.0175%, about 0.001% to about 0.02%, about 0.001% to about 0.03%, about 0.001% to about 0.04%, about 0.0025% to about 0.01%, about 0.0025% to about 0.0125%, about 0.0025% to about 0.015%, about 0.0025% to about 0.0175%, about 0.0025% to about 0.02%, about 0.0025% to about 0.03%, about 0.0025% to about 0.04%, about 0.005% to about 0.01%, about 0.005% to about 0.0125%, about 0.005% to about 0.015%, about 0.005% to about 0.0175%, about 0.005% to about 0.02%, about 0.005% to about 0.03%, about 0.005% to about 0.04%, about 0.0075% to about 0.01%, about 0.0075% to about 0.0125%, about 0.0075% to about 0.015%, about 0.0075% to about 0.0175%, about 0.0075% to about 0.02%, about 0.0075% to about 0.03%, about 0.0075% to about 0.04%, about 0.01% to about 0.0125%, about 0.01% to about 0.015%, about 0.01% to about 0.0175%, about 0.01% to about 0.02%, about 0.01% to about 0.03%, or about 0.01% to about 0.04% by weight of the first reaction solution.

6142. The method according to claim 59-40 or 6410, wherein the third period of time is longer in duration than the fourth period of time.

~~62~~43. The method according to any one of claims ~~59-61~~40-42, wherein the fourth period of time is about 5 minutes to about 10 minutes, about 5 minutes to about 15 minutes, about 5 minutes to about 20 minutes, about 5 minutes to about 30 minutes, about 10 minutes to about 15 minutes, about 10 minutes to about 20 minutes, about 10 minutes to about 30 minutes, about 15 minutes to about 20 minutes, about 15 minutes to about 30 minutes, or about 20 minutes to about 30 minutes.

~~63~~44. The method according to any one of claims ~~59-62~~40-43, further repeating peroxide addition and chlorine gassing steps as defined in claims ~~59-61~~40-43 one or more additional times, wherein the resulting subsequent reaction solution has higher levels of one or more free available chlorine species and one or more peroxides as compared to the previous reaction solution.