SUMMARY OF LITERATURE SEARCH ON COPPER LEACHING INTO DRINKING WATER FROM COPPER PIPE

#7

The following summary has three components:

A. Know and Suspected Toxicity of Copper to Humans and Other Living Organism.

B. Pipes Leaching Copper and Other Contaminants Into The Drinking Water.

C. Scientific Community Recommendations on Copper in Drinking Water.

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A Known and Suspected Toxicity of Copper to Humans and Other Living Organism

1. From CalEPA's Office of Environmental Health Hazard Assessment:

The California Safe Drinking Water Act of 1996 (amended Health and Safety Code, Section 116365) requires the Office of Environmental Health Hazard Assessment (OEHHA) to adopt Public Health Goal (PHGs) for contaminants in drinking water based exclusively on public health considerations. The PHG technical support document provides information on health effects from contaminants in drinking water. The PHG describes concentrations of contaminants at which adverse health effects would not be expected to occur, even over a lifetime of exposure. PHGs are developed for chemical contaminants based on the best available toxicological data in the scientific literature. These documents and the analyses contained in them provide estimates of the levels of contaminants in drinking water that would pose no significant health risk to individuals consuming the water on a daily basis over a lifetime.

A PHG of 170 ppb has been developed for copper in drinking water.

Copper does not appear to be carcinogenic in animals or humans, therefore the PHG is based on noncarcinogenic effects. The PHG is based on gastrointestinal effects in children, the sensitive group for this chemical. In one case report of a Vermont family that consumed drinking water with a copper concentration of 7.8 mg/L, a seven-year-old girl experienced abdominal pain and a five-year-old girl experienced episodes of vomiting and abdominal pain after drinking the water. To calculate the lowest-observed-adverse-effect-level (LOAEL) the water consumption of the two girls was estimated at one liter per day. An uncertainty factor of 10 was employed to extrapolate from an LOAEL to a no-observed-adverse-effect-level (NOAEL), and a relative source contribution of 80% was assumed. Based on these assumptions, OEHHA calculates a PHG of 0.17 mg/L (170 ppb) for copper in drinking water.

2. The Department of housing and Community Development, under the State Housing Law, has the authority to regulate the material used for water pipe within the residential structure and is required under Health and Safety Code Section

17921 to propose for adoption California Buildings Standards Code for the protection of the public health, safety, and general welfare of the residential occupant.

3. Another agency, the Department of Health Services (DHS), regulates the piping material used in the distribution system up to the residential structure and allows the use of CPVC piping in Title 22 of their regulations. Because DHS only regulates the distribution system up to the residences and not inside, their regulations for mitigating copper leaching from copper pipe inside residents is to require the public water districts (greater than 50,000 services) to condition the water and try to prevent excessive leaching inside residential structures. The water conditioning requirements are based in part on health and in part on the cost of chemicals required to prevent copper leaching. Since DHS does not have the authority to regulate the water pipe material within the residential structure they cannot require building standards that would allow an alternative pipe for copper pipe.

4. The following health and environmental problems have been identified by various health organizations and groups as potential toxic problems associated with copper in drinking water. The below comes from the Environmental Defense and have hyperlinks attached.

Human Health Hazards	**Reference(s)**
Cardiovascular or Blood Toxicant	KLAA
Developmental Toxicant	EPA-SARA
Gastrointestinal or Liver Toxicant	ATSDR DOSS KLAA RTECS ZIMM
Kidney Toxicant	MERCK
Reproductive Toxicant	EPA-SARA FRAZIER
Respiratory Toxicant	

5. The National Research Council (NRC)[1] stated that the current health level established by U.S. EPA for copper is for acute exposure and is not suitable for establishing a health base level for MCLG (maximum contaminant level goal). The need to develop a chronic exposure level is necessary and will be much lower concentration.
6. The average absorption of copper by the body is controlled by the liver function and is 30% to 40% and is influenced by age and genetic background. (see NRC 2000 Report)

[1] At the direction of Congress, U.S. EPA asked the National Research Council (NRC) to review independently the scientific and technical basis for U.S. EPA's health level for copper in drinking water. The Committee members were from the fields of toxicology, epidemiology, pathology, pharmacology, genetics, physiology, medicine, public health, exposure assessment, nutrition, chemistry, biostatistics, and risk assessment. The Committee reviewed available toxicological, epidemiological, and exposure data and made specific recommendations in their 2000 published report titled "Copper in Drinking Water," Committee on Copper in Drinking Water, Board of Environmental Studies and Toxicology, Commission on Life Sciences, National Research Council.

7. Infants fed formula with tap water are much more sensitive to elevated copper in water because they have a higher absorption rate and educed capacity to excrete copper as those of an older age. (see NRC 2000 Report)
8. Evidence suggests that when the bodies ability to regulate copper is surpassed by excess copper, a large amount of copper is released into the bloodstream damaging red blood cells and causing acute hemolytic anemia. (see NRC 2000 Report)
9. Because reproductive and development effects are affected by small amounts of copper intrauterine devices by preventing embryuogenesis by blocking implantation and blastocyst development that copper exposure during the early postnatal period requires additional study to determine teratogency during pregnancy. (see NRC 2000 Report)
10. The ingestion of copper should be cautioned against because of the possibility of the hepatic (liver) susceptibility. (see NRC 2000 Report)
11. There is the potential role of genetics that underlie infant and childhood copper toxicosis. (see NRC 2000 Report)
12. There is an association between liver toxicity and copper in sensitive population (Wilson Disease-2% of population). (see NRC 2000 Report)
13. A Wisconsin Department of Health and Social Service's Division of Health study stated Health studies have found that copper in drinking water can add 4 to 45 percent more copper to a person's diet than what is in food sources.
14. Chronic exposure to excess copper causes liver toxicity and a number of chronic cases of liver toxicity have been reported. (see NRC 2000 Report)
15. In sensitive human populations, the majority target of chronic copper toxicity is the liver and neurological toxicity with those with Wilson disease. (see NRC 2000 Report)
16. The liver and brain are targets of copper toxicity in patients with Wilson disease. (see NRC 2000 Report)
17. Excess digestion of copper in drinking water can cause nausea, diarrhea, vomiting, and intestinal cramps. Severe cases of copper poisoning have lead to anemia and to the disruption of liver and kidney functions. They also sated that individuals with Wilson's and Menke's disease (genetic disorders resulting in abnormal copper absorption and metabolism) are at a higher risk from copper exposure than the general public and can have serious health problems. (see NRC 2000 Report)
18. Dr Lewis Mehl-Madrona, M.D., Ph.D, Program Director, Center for Health and Healing, Beth Israel Hospital/Albert Einstein School of Medicine reported that studies suggest that environmental factors associated with learning disabilities such as Attention-Deficit/Hyperactivity Disorder (ADHA) have found correlations between certain toxic agents such as copper accumulating in brain tissue.
19. Dr. William Walsh, Ph.D., Co-Founder and Senior Scientist for "The Health Institute and Pfeiffer Treatment Center" suggested that studies point to a potential correlation for Autism Disorder and copper injustion that could impair neuronal development, especially in the first 30 months of life, which could result in incomplete maturation of the G.I. track and brain.
20. Research is being carried out by Ashley Bush, Harvard Medical School and the University of Melbourne and the PRANA Biotech School Melbourne that studies the a link of copper accumulation in the brain that causes a buildup of hydrogen peroxide which induces amaloid plaques in the brain i.e., Alzheimer's disease.

21. An old antibiotic, Clioquinoline, is now being tested on 50 Alzheimer's patients according to Dr. Ashley Bush of Massachusetts General Hospital and Harvard Medical School. The drug was effective in mice experiments because it removed copper and zinc in amaloid plaques in the brain that are a major feature of alzheimer's. There was a 51 percent reduction in the plaques in the mice and the hope is that for humans it will aid the brain to "heal" itself to "clear out the mess" causing Alzheimer's.

22. In 1992 a 6 week old girl was diagnosed with methemoglobinemia induced by simultaneous exposures of copper at levels close to the federal drinking water standards. The study stated that drinking water that stands overnight in copper pipes may often contain copper levels that exceed federal drinking water standards and that the water should be flushed prior to drinking water that stands overnight in copper pipes according to the investigation by the Wisconsin Department of Health and Social Service's Division of Health.

23. Two Material Safety Data Sheet states that copper may cause anemia and other blood cell abnormalities and copper accumulates in various tissues and may result in liver, kidney, and brain damage. It has also been reported that copper poisoning has lead to hemolytic anemia and accelerates arteriosclerosis.

24. The Medical Toxicology Unit from Guy's and St. Thomas' Hospital stated that "Chronic poisoning with copper leads to gross hepatic copper overload with severe liver disease in young children. Indian childhood cirrhosis have reports of poisoning in young children as a result of high copper content in well water

25 The NRDC cited a study (Sidhu, K 1995[2]) in its report that recommended decreasing the federal maximum allowed amount of Cu in drinking water in order to adequately protect children[3]. This study found that infants and children up to ten years of age have greater sensitivity due to the presence of normally high concentrations of copper in the liver during early life and the lack of a fully developed physiological mechanism for regulating levels of copper in the body. One study, recognizing this difference, recommended decreasing the federal maximum allowed amount of Cu in drinking water in order to adequately protect children.[6][7]

26. In a report by the International Programme of Chemical Safety titled "Environmental Health Criteria 200 Copper the following findings were made:

(1) Ingestion of excess Copper (EHC 200, 1998) copper is infrequent in humans and is usually a consequence of the contamination of beverages (including drinking-water) or from accidental or deliberate ingestion of high quantities of copper salts. Effects which occur at lowest levels are those on the gastrointestinal tract; for example, nausea, vomiting and diarrhoea. Doses which induce such effects have not been well characterized and confounders such as microbiological quality of water supplies or other potential causes of the symptoms have not been adequately considered. On the basis of available data, gastrointestinal illness appears to be associated with consumption of drinking-water containing several mg/litre of copper, but it is not possible to provide a precise number. Symptoms disappear following a change of water supply.

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[2] Sidhu, K. et al., "Need to Revise the National Drinking Water Regulation for Copper," Regulatory Toxicology and Pharmacology 22, August 1995, pp. 95-100.

[3] From "Toxic Chemicals & Health: Kids' Health: In Depth: Report; Our Children At Risk: The 5 Worst Environmental Threats To Their Health; **CHAPTER 7; DRINKING WATER CONTAMINATION; Introduction**

(2) Human health risks are risks associated with low intakes as well as high intakes of essential elements. The relationship between intake/exposure level and risk therefore has a U-shaped curve, wit risks from deficiency at low intakes and risk of toxicity at high intakes. There is a need to define an intake range that prevents both deficiency and toxicity for the general population. The range of acceptable intakes to meet the biological requirement, as well as prevent risk of toxicity, may be extremely narrow. A balanced and comparable scientific approach to assess risk from deficit as well as excess is needed when evaluating essential elements such as copper.

(3) When copper homoeostatic control is defective and/or copper intake is excessive, copper toxicity may occur.

(4) People with Menkes and Wilson disease are at risk with copper contained drinking water.

(5) Menkes disease is an X-linked recessive disorder of copper metabolism that occurs in approximately 1 in 200 000 live births. Clinically the condition resembles a copper deficiency state and is characterized by skeletal abnormalities, severe mental retardation, neurological degeneration and death in early childhood. The symptoms of Menkes disease result from a deficiency of copper and its effects on the function of copper-dependent enzymes.

(6) Wilson disease is the most extensively described inherited disorder of copper metabolism. The gene is distributed worldwide, having been demonstrated in virtually all races. Current global estimates indicate that the incidence rate of the disease is approximately 1 in 30 000 live births, with prevalency ranging from 15 to 30 per million. The gene frequency varies between 0.3 and 0.7%,corresponding to a h Copper (EHC 200, 1998)

(7) Idiopathic copper toxicosis, or non-Indian childhood cirrhosis Scattered reports of early childhood cirrhosis similar to ICC, referred to as copper-associated idiopathic copper toxicosis (ICT) have appeared from some Western countries (Walker-Smith & Blomfield,1973; Müller-Höcker et al., 1987; Adamson et al., 1992; Gormally et al., 1994).Copper (EHC 200, 1998)

(8) In England a correlation study, with measurements made after diagnosis of coronary heart disease, has shown higher serum copper levels in cardiovascular disease patients (Punsar et al., 1975).

(9) Available data in humans and animals are inadequate to assess the reproductive/developmental effects of copper compounds on humans..

(10) Bioaccumulation of copper by microorganisms, plants or animals from their surrounding environment can be adverse and must be studied further.

(11) Copper exhibits significant toxicity to some aquatic organisms, although the degree of toxicity is highly variable and the bioavailability of copper dictates its toxicity to a large extent.

B. Copper Water Pipes Leaching Copper and Other Contaminants Into The Drinking Water

1. "Copper Water Pipe Fittings Subject to Proposition 65 Warnings

Copper water pipe fittings, such as 90 degree street elbows, are subject to Proposition 65 warnings because they contain high levels of lead and are subject to warning label requirements from OEHHA as a material and chemical in the State's drinking water sources known to cause cancer, birth defects, or other reproductive harm. These warning labels are only viewed by the installers of the copper pipe fittings and homeowners are not given this warning. (see attached Elkhart Production Corporation Prop 65 warning)

2 The Department has found that there are existing residential homes in California with copper pipe that leach copper at levels exceeding federal MCL levels for copper (1,300 ppb)[4] and California's PHG[5] (170 ppb). The data in California is for water from inside households. The Lead and Copper Rule[6] requires limited sampling of public water systems serving 50,000 people or more for copper and lead. The Department reviewed sampling reports from 32 different California water districts that sampled less than 1,000 homes (see attached excel summary sheet). The data showed that all 32 water districts measured copper concentration in excess of the PHG in 90 percent of the homes tested. The average copper concentrations at the 90 percentile level was 446 ppb with the range from 170 to 2,400 ppb with 4 districts reporting that 90 percent of the homes were above 1,000 ppb. Approximately 8 homes have exceeded the federal MCL level of 1,300 ppb for copper in drinking water.

If it is assumed that the 1,000 homes tested were a statistically representative population for the 90 percentile measurement by the 32 water districts (greater than 50,000 services) then there could be 45,000 homes (50,000 x .9 = 45,000) with copper concentration above the PHG and 400 homes (8 x 50,000/1,000) above the acute level MCL level of 1,300 ppb. DHS reports that there are approximately 7,441 public water districts in California.

3. The above household water testing data is consistent with the Department's literature search on copper leaching into drinking water from copper pipe. According to the U.S. EPA,[7] the National Research Council (NRC)[8] and the

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[4] MCL is a one time copper concentration dose determined to be an acute not chronic health hazard.

[5] For copper the PHG is set at a level that is not expected to cause any toxic effects, including birth defects and chronic illness. State law requires DHS to set drinking water standards for chemical contaminants as close to the corresponding PHG as is economically and technically feasible. In some cases, it may not be feasible for DHS to set the drinking water standard for a contaminant at the same level as the PHG. The technology to treat the chemicals at the water treatment plant may not be available, or the cost of treatment may be very high. DHS must consider these factors when developing a drinking water standard. Since DHS does not have the authority to regulate copper pipe within a residential structure, such as requiring an alternative material such as CPVC, they only regulated the water districts with greater than 50,000 services by requiring the supplied water to be conditioned at the water treatment plant to reduce the capacity of the copper to leach into the drinking water from the copper pipe within the residents.

[6] CCR title 22, Division 4, Chapter 17.5.

[7] USEPA Ground Water and Drinking Water Technical Fact Sheet on Copper.

[8] At the direction of Congress, U.S. EPA asked the National Research Council (NRC) to review independently the scientific and technical basis for U.S. EPA's health level for copper in drinking water. The Committee members were from the fields of toxicology, epidemiology, pathology, pharmacology, genetics, physiology, medicine, public health, exposure assessment, nutrition, chemistry, biostatistics, and risk assessment. The Committee reviewed available toxicological,

American Water Works Association, metallic copper is unstable and subject to corrosion when in contact with water and it is a "*mistake to*" assume that copper pipe will "not leach into the drinking water" even if the water is termed non-corrosive or water treated to make it less corrosive.

4. Copper leaches into the drinking water from the time of installation until about 10 years of service life when a calcium deposit forms on the pipe to inhibit leaching.

5. Water softeners using ion exchange in new homes with copper pipe are likely to have increase copper contamination levels in the drinking water because it inhibits the formation of the calcium deposits. (See NRC 2000 Report) The town of Discovery Bay in California made this finding on the issue of water softeners on homes with new copper pipe. (see letter from Virgil Koehne, General Manager of the Town of discovery Bay, August 22, 2003.)

6. Copper pollution from new subdivision in the Town of Discovery Bay, California, has lead to a NPDES permit issued by the California Regional Water Quality Control Board requiring the removal of copper from the water supply through a "Pollution Prevention Plan."

7. A review of the Associated Laboratories data developed from July 17 through July 25, 2002 at the Murrieta Ranchos Development in the City of Murrieta, California showed copper concentrations from 22 homes ranging from a low of 146 ppb to a high of 2,400 ppb. The Public Health Goal for copper in drinking water as established by CalEPA's Office of Environmental Health Hazard Assessments is 170 ppb. 21 of these homes have exceeded this PHG level. The average pH of the water tested was 7.4 which is slightly basic not acidic.

8. According to the U.S. EPA[9] and the National Research Council (NRC), metallic copper is unstable and subject to corrosion when in contact with water and it is a "mistake to" assume that copper metal (Cu) and its alloys "do not leach into the drinking water." This includes water termed non-corrosive or water treated to make it less corrosive. Copper occurs in drinking water primarily due to its use in plumbing materials. Copper leaching continues from installation until about 10 year of service.

9. A 1975 AWWA Journal reported that corrosion of household Cu plumbing was a major source of Cu metal contamination in U.S. drinking water.

10. The Agency for Toxic Substances and Disease Registry (ATSDR)[10] created the "Public Health Statement for Copper" which states that you may be exposed to high levels of soluble copper in your drinking water, especially if your water is

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epidemiological, and exposure data and made specific recommendations in their 2000 published report titled "Copper in Drinking Water," Committee on Copper in Drinking Water, Board of Environmental Studies and Toxicology, Commission on Life Sciences, National Research Council.

[9] USEPA Ground Water and Drinking Water Technical Fact Sheet on copper.

[10] ATSDR is an agency of the U.S. Department of Health and Human Services whose purpose is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related to toxic substances.

corrosive and you have copper plumbing and brass water fixtures. The average concentration of copper in tap water ranges from 20 to 75 parts per billion (ppb). However, many households have copper concentrations of over 1,000 ppb (near the upper limit of U.S. EPA's Maximum Contaminant Level. This is because copper is picked up from copper pipes and brass faucets when the water sits in the pipes overnight. After the water is allowed to run for 15-30 seconds, the concentration of copper in the water decreases.

11. Several states have measured copper concentrations in drinking water from Cu pipes that exceeds U.S. EPA MCLG levels. (See NRC 2000 Report)

12. Water softeners using ion exchange are likely to have increase copper contamination levels in the drinking water. (See NRC 2000 Report)

13. Washington State Department of Health stated that most copper in drinking water comes from household plumbing and that copper contamination can accumulate overnight (called "first flush") and recommends that households flush their water before use for the first 30 to 45 seconds.

14. A Wisconsin Department of Health and Social Service's Division of Health study stated that "first flush" drinking water in copper pipes often contain copper levels that exceed federal drinking water standards and should be flushed prior to drinking.

15. Copper pollution in the Town of Discovery Bay, California has lead to a NPDES permit issued by the California Regional Water Quality Control Board requiring the removal of Cu from the water supply through a "Pollution Prevention Plan." The major cause of copper pollution is from the use of water softeners that are installed on copper piping systems in homes of Discovery Bay. (see letter from Virgil Koehne, General Manager of the Town of discovery Bay, August 22, 2003.)

16. In February 1997, the Office of Drinking Water for the U.S. EPA Environmental Criteria and Assessment Office reported that a majority of copper present in drinking water appeared to come from copper pipes and they were unable to estimate the number of individuals who regularly consume water that exceed safe MCL (Maximum Contaminant Level) levels for copper.

17. Each year thousands of pounds of copper enter the San Francisco Bay, and the accumulation is harming aquatic life. Research shows that corrosion from newly installed copper pipes is 5 times higher than that from older systems. A Copper Action Plan for the NPDES permit for Palo Alto whose receiving waters are the San Francisco Bay estimated in 2002 that corrosion accounts for 60% of the estimated Cu sources. The Regional Water Quality Control Plant's discharge permit (Order No. 00-109) requires outreach to plumbers and designers to reduce corrosion of copper pipe via better design and installation.

18. An article published a recent issue of the Wisconsin Medical Journal detailed two separate cases in Wisconsin reported that ingestion of copper-contaminated drinking water resulted in numerous reports of nausea, vomiting and abdominal

discomfort because of new copper piping systems. Samples analyzed showed copper level exceeding Federal MCL levels. In the following weeks, 251 families submitted first drawn water samples (after sitting overnight) and 48 had copper levels that exceeded federal limits. The homes were built in the past 10 years had the highest copper levels in the water.

19. Test carried our in Victoria in 1976 by the State Water Supply commission indicated that fluoride is involved in the corrosion of the copper pipes, which causes more leaching into the water. Leaving fluorinated water standing in the copper pipes for longer periods of times allows for more corrosion. Countries such as Switzerland, Belgium, Holland, Germany, and Sweden have terminated the use of fluoride due to its potential health hazard.

20. The presence of acidic water in household plumbing systems resulted in levels of copper or zinc up to 9,000 ppb being recorded in water from cold taps, and up to 22,500 ppb from hot taps. (IRC 2000 , Section R324)

21. In the City of Highland, the Richmond Creek subdivision experienced 175-200 pin hole leeks in the 67 homes (Letter to Department from Richmond American Homes of California, March 1, 1993)

22. The initiation of pits in copper water tubing has been correlated to carbon films left on the surface during manufacturing, flux residues from soldering, debris left in tubes during installation and water chemistry parameters (Chester Neff, P.E. Chemist, July 31, 1991 Letter to DEC Consultants in San Diego)

C. Scientific Community Recommendations on Copper in Drinking Water

1. Office of Environmental Health Hazard Assessment (OEHHA) established in 1997 the current Public Health Goal of 0.17 mg/L (ppb) for copper which was based on acute gastrointestinal effects in children. OEHHA is currently reviewing the 1997 standard and staff has suggested that a target level of copper in drinking water, measured at the tap, should be in the range of 0.1 to 0.3 mg/L (ppb), i.e., at about the level of the PHG.

2. The National Research Council (NRC)[11] stated that because reproductive and development effects are affected by small amounts of Cu intrauterine devices by preventing embryuogenesis by blocking implantation and blastocyst development that Cu exposure during the early postnatal period requires additional study to determine teratogency during pregnancy. The reproductive and development

[11] At the direction of Congress, U.S. EPA asked the National Research Council (NRC) to review independently the scientific and technical basis for U.S. EPA's health level for copper in drinking water. The Committee members were from the fields of toxicology, epidemiology, pathology, pharmacology, genetics, physiology, medicine, public health, exposure assessment, nutrition, chemistry, biostatistics, and risk assessment. The Committee reviewed available toxicological, epidemiological, and exposure data and made specific recommendations in their 2000 published report titled "Copper in Drinking Water," Committee on Copper in Drinking Water, Board of Environmental Studies and Toxicology, Commission on Life Sciences, National Research Council.

effects of excess copper is not well known other that small amounts of copper from intrauterine devices can prevent embryuogenesis by blocking implantation and blastocyst development. The committee commended that copper exposure during the early postnatal period requires additional study to determine teratogency during pregnancy. (see NRC 2000 report)

The NRC stated that because reproductive and development effects are affected by small amounts of Cu intrauterine devices by preventing embryuogenesis by blocking implantation and blastocyst development that Cu exposure during the early postnatal period requires additional study to determine teratogency during pregnancy.

3. The NRC recommended that increased in the ingestion of Cu should be cautioned against until the hepatic (liver) susceptibility is clearly identified.

4. The NRC recommended that studies be conducted to characterize the potential role of genetics that underlie infant and childhood copper toxicosis.

5. The NRC recommended genetic animal models be used to determine the associations between liver toxicity and Cu in sensitive population (Wilson Disease-2% of population).

6. The NRC recommended that epidemiological studies of population who have been chronically exposed to elevated copper should be carried out to determine the nature and frequency of chronic effects, especially in sensitive populations.

7. Given the potential risk for toxicity in humans, quantification of copper toxicity should be undertaken and the MCLG for copper be re-evaluated. NRC stated the current health level established by U.S. EPA for copper is based on acute exposure to copper and is not suitable for establishing a MCLG (maximum contaminant level goal). A chronic exposure level is necessary for the MCLG

8. Determine the bioavailability of dietary copper, particularly in vegetarian diets.

9. In human populations develop the methodology for identifying adverse effects of marginal copper deficiency and of intakes in excess of recommended levels. This should include an evaluation of stable isotope technology to define bioavailability and body stores of copper.

10. Determine the concentrations of copper and the other quality parameters of drinking-water that produce toxicity from single and chronic exposures (e.g. gastrointestinal effects).

11. Characterize the mechanisms that influence copper homoeostasis including placental transfer of copper.

12. The Agency for Toxic Substances and Disease Registry[12] which created the "Public Health Statement for Copper" stated that because many households have copper concentrations of "first drawn" water over 1,000 ppb (near the upper limit of U.S. EPA's Maximum Contaminant Level that after the water is allowed to run for 15-30 seconds, the concentration of copper in the water decreases.

13. A Wisconsin Department of Health and Social Service's Division of Health study stated that drinking water that stands overnight in copper pipes may often contain copper levels that exceed federal drinking water standards and that the water should be flushed prior to drinking water that stands overnight in copper pipes according to the investigation.

14. Known Copper pollution in the Town of Discovery Bay, in Danville, CA that has a California Regional Water Quality Control Board NPDES permit with a requirement for a Pollution Prevention Plan to remove copper from the water supply. The recommendation will be to replace the copper pipe for new homes with alternative plastic pipe.

15. A Washington State Department of Health and Social Division of Health Study stated that most copper in drinking water comes from household plumbing and that copper contamination can accumulate overnight (called "first flush") and recommends that households flush their water before use for the first 30 to 45 seconds.

16. The Nebraska Health and Human Services recommends flushing household water supply prior to use if it has stood in pipes for six hours or more and this water should not be used for drinking or cooking. If you live in an apartment complex, flushing may not be as effective for reducing copper levels. Water from the hot water tab shouldn't be used for drinking or cooking. If the results of water testing show elevated copper levels, flushing may not be adequate for children or infants and an alternate source of water my be needed.

17. The NRC stated that the current health level established by U.S. EPA for Cu is for acute exposure and is not suitable for establishing a health base level for MCLG (maximum contaminant level goal). The need to develop a chronic exposure level is necessary and will be much lower concentration.

18. The Regional Water Quality Control Plant's discharge permit (order No. 00-109) requires outreach to plumbers and designers to reduce corrosion of copper pipe.

19. The NRDC cited a study (Sidhu, K 1995[13]) in its report[14] that recommended decreasing the federal maximum allowed amount of Cu in drinking water in order

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[12] ATSDR is an agency of the U.S. Department of Health and Human Services whose purpose is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related to toxic substances.

[13] Sidhu, K. et al., "Need to Revise the National Drinking Water Regulation for Copper," Regulatory Toxicology and Pharmacology 22, August 1995, pp. 95-100.

[14] From "Toxic Chemicals & Health: Kids' Health: In Depth: Report; Our Children At Risk; The 5 Worst Environmental Threats To Their Health; **CHAPTER 7; DRINKING WATER CONTAMINATION; Introduction**

to adequately protect children. This study found that infants and children up to ten years of age have greater sensitivity due to the presence of normally high concentrations of copper in the liver during early life and the lack of a fully developed physiological mechanism for regulating levels of copper in the body. One study, recognizing this difference, recommended decreasing the federal maximum allowed amount of Cu in drinking water in order to adequately protect children.[67]