

This Research Agreement (“Agreement”) is made effective as of **June 30, 2016** (the “Effective Date”), by and between Virginia Polytechnic Institute and State University (hereinafter referred to as “Virginia Tech”), and **The City of Fresno, California** (hereinafter referred to as the “Sponsor”). Party shall mean the Sponsor or Virginia Tech as the context dictates, and when used in the plural, shall mean the Sponsor and Virginia Tech.

WHEREAS, the research scope described by this Agreement is of mutual interest and benefit to Virginia Tech and to the Sponsor, and will further the instructional and research objectives of Virginia Tech in a manner consistent with its status as a non-profit, tax-exempt, educational institution.

NOW, THEREFORE, the Parties hereto agree as follows:

1. PERIOD OF PERFORMANCE. The Research shall be conducted during the period commencing **September 22, 2016** (the “Start Date”) and, unless earlier terminated in accordance with this Agreement, ending **June 30, 2017** (the “Completion Date”). The Completion Date may be modified or extended only by mutual written agreement of the Parties.

2. STATEMENT OF WORK. Virginia Tech agrees to use reasonable efforts to perform the research program as described in Attachment A (the “Research”) to this Agreement. Any change within the scope of the Research requires a written modification to this Agreement. If any such change causes an increase or decrease in the price of, or the time required for, performance of any part of the work under this Agreement, or otherwise affects any other terms and conditions of this Agreement, an equitable adjustment shall be made in the cost, delivery or completions schedule, or both, and other affected terms and this Agreement shall be modified accordingly.

3. PRINCIPAL INVESTIGATOR. The Research will be supervised by **Dr. Marc Edwards** the “Principal Investigator”. If, for any reason, he is unable to continue to serve as Principal Investigator and a successor reasonably acceptable to both Virginia Tech and the Sponsor is not available, this Agreement shall be terminated as provided in Article 4 herein. This Agreement does not limit the freedom of

individuals participating in this Research Program to engage in any other research.

4. TERMINATION. This Agreement may be terminated by either Party for its convenience upon sixty (60) days prior written notice to the other Party. Upon termination by either Party, Virginia Tech will be reimbursed for all costs incurred and non-cancelable commitments incurred in connection with the Research up to and including the effective date of termination. If any Virginia Tech student is supported under this Agreement and Sponsor terminates this Agreement, Sponsor will remain responsible for the full cost of the student support through the end of the academic semester in which this Agreement is terminated. Sponsor will be provided the results of the Research generated prior to the date of termination.

5. COSTS. For the purposes of this Agreement, “Cost” means all direct and indirect costs incurred by Virginia Tech in conducting the Research up to the amount of \$130,000.

5.1 Designation. This Agreement is designated as: Fixed Price

5.2 Cost-Reimbursable Agreement. If this Agreement is designated as “Cost-Reimbursable,” Sponsor will reimburse Virginia Tech for the Cost of conducting the Research. The parties estimate that the Cost is sufficient to support the Research Program, but Virginia Tech may submit to Sponsor a revised budget requesting additional funds if costs are reasonably projected to exceed the Cost. Sponsor is not liable for any payment in excess of the Cost except on Sponsor’s written agreement. Virginia Tech is under no obligation to continue work and/or incur costs exceeding the Cost.

5.3 Fixed-Price Agreement. If this Agreement is designated as “Fixed Price,” Sponsor will pay Virginia Tech the Cost. The parties estimate that the Cost is sufficient to support the Research Program. Virginia Tech may submit to Sponsor a revised budget requesting additional funds if Sponsor requests a change in the Research. Sponsor will not be liable for any payment in excess of the Cost except on Sponsor’s written agreement. Virginia Tech is under no obligation to continue work beyond initial scope and/or incur costs for a revision in the Research which

will require additional funds if Sponsor has not agreed in writing to provide the additional costs.

6. PAYMENTS. Payments shall be made to Virginia Tech by the Sponsor in accordance with the following schedule: Sponsor shall pay \$32,500 upon execution of the agreement; \$32,500 on January 1, 2017; \$32,500 on April 1, 2017; and \$32,500 upon delivery of the Final Report. Sponsor shall pay invoices within thirty (30) days of receipt of invoices.

6.1 Payment Identification. For purposes of identification each wire or check payment must refer to the Research title, the Agreement number, and the name of the Principal Investigator.

6.2 Virginia Tech Payment Contact.

Alice Hamblin
Virginia Polytechnic Institute and State University
Tax ID Number: 54-6001805
Office of Sponsored Programs
North End Center
300 Turner Street NW, Suite 4200
Blacksburg, Virginia 24061

6.3 Sponsor Payment Contact. Invoices to Sponsor will be sent to:

City of Fresno
Attention: Thomas C. Esqueda
2600 Fresno Street
Fresno, CA 93721

7. INSURANCE. Virginia Tech will maintain Worker's Compensation insurance or other coverage on its employees as required by Virginia State law, and will self-insure or maintain insurance covering its liability under this Agreement. Upon

request, Virginia Tech shall provide a Certificate of Insurance evidencing said insurance.

If Sponsor: a) provides any materials, equipment, or other property to Virginia Tech for use in the Research or b) if Research involves human subjects, then Sponsor will procure and maintain during the term of this Agreement comprehensive liability and product liability insurance to the full amount of Sponsor insurance limits, but in no event less than \$1,000,000 per occurrence, with a reputable and financially secure insurance carrier. - Upon request, Sponsor shall provide a Certificate of Insurance evidencing said insurance.

8. EQUIPMENT. Title and ownership of any equipment purchased under this Agreement shall vest in Virginia Tech.

9. PUBLICATIONS. The basic objective of Research at Virginia Tech is to perform fundamental research and share the results broadly within the scientific and academic communities for the public's benefit. Sponsor will provide all reasonable cooperation in meeting this objective. Furthermore, timely publication of research results in the most respected academic, peer-reviewed journals and conferences is essential to the career advancement of Virginia Tech's faculty, research associates and graduate students. Virginia Tech will provide Sponsor with a copy of any manuscript or other publication at least 30 days before it is submitted for publication. Sponsor may review the manuscript or publication:

- (a) To ascertain whether Sponsor's Confidential Information would be disclosed by the publication;
- (b) To identify potentially patentable technology so that appropriate steps may be taken to protect the technology; and
- (c) To confirm that the privacy rights of individuals are adequately protected.

Sponsor will provide comments, if any, within 30 days of receiving the manuscript or publication. If patentable technology is disclosed in the manuscript or publication, Sponsor will promptly advise Virginia Tech and Principal Investigator

may agree to an additional review period not to exceed sixty (60) days. Failure to provide comments during the review period will be de facto agreement to publication.

10. REPRESENTATIONS AND WARRANTIES. VIRGINIA TECH MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE RESEARCH OR ANY INTELLECTUAL PROPERTY RIGHTS AND HEREBY DISCLAIMS ALL REPRESENTATIONS AND WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS OF VIRGINIA TECH OR THIRD PARTIES, CREATION, VALIDITY, ENFORCEABILITY AND SCOPE OF ANY INTELLECTUAL PROPERTY RIGHTS OR CLAIMS, WHETHER ISSUED OR PENDING, AND THE ABSENCE OF LATENT OR OTHER DEFECTS, WHETHER OR NOT DISCOVERABLE.

IN NO EVENT SHALL EITHER PARTY, ITS TRUSTEES, DIRECTORS, OFFICERS, EMPLOYEES, STUDENTS AND AFFILIATES, BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, INCLUDING ECONOMIC DAMAGES OR LOST PROFITS, REGARDLESS OF WHETHER THE PARTY WAS ADVISED, HAD OTHER REASON TO KNOW OR IN FACT KNEW OF THE POSSIBILITY OF THE FOREGOING. THIS ARTICLE 10 SHALL SURVIVE THE EXPIRATION OR ANY EARLIER TERMINATION OF THIS AGREEMENT.

Sponsor acknowledges that the Research is a scientific undertaking and, consequently, Virginia Tech will not guarantee any particular outcome or specific yield.

11. INDEMNIFICATION. Sponsor will defend, indemnify and hold Virginia Tech harmless from any liability, damage, loss, or expense arising out of Virginia Tech's use of resources provided by Sponsor for the purpose provided by Sponsor.

12. PROPRIETARY INFORMATION. “Proprietary Information”, for the purposes of this Agreement, shall mean certain proprietary or confidential business or technical information including, but not limited to, technical, financial, commercial, marketing or other business information relating to the subject matter of the research to be performed under this Research, that the disclosing party desires to protect against unrestricted disclosure or competitive use. To be subject to this Agreement, information disclosed in writing must be labeled with an appropriate proprietary legend. If disclosed verbally or visually, Proprietary Information shall be designated as proprietary at the time of such disclosure, with subsequent confirmation provided in writing within ten (10) calendar days following such disclosure, referencing the date and description of the Proprietary Information disclosed with an appropriate proprietary legend affixed thereto. Proprietary Information disclosed by Virginia Tech may include invention disclosures or other confidential information of Virginia Tech Intellectual Properties, Inc. (VTIP), a nonprofit corporation that manages and licenses intellectual properties assigned to it by Virginia Tech.

For a period of three (3) years from the date of disclosure (or in case of trade secrets, as long as such proprietary information remains a trade secret), the receiving party shall:

- (a) Protect received Proprietary Information from disclosure to third parties with at least the same degree of care (but no less than a reasonable degree of care) as it uses to protect its own proprietary or confidential information of like kind from unauthorized use or disclosure;
- (b) Limit the access to and dissemination of received Proprietary Information only to those individuals who have a need for such information to fulfill the Purpose stated herein and have been notified of and agree to the obligations imposed by this Agreement;
- (c) Use received Proprietary Information only in furtherance of the Purpose; and
- (d) Not reproduce received Proprietary Information or incorporate it into derivative works or notes unless necessary to fulfill the Purpose, and in

such case only if that Proprietary Information continues to be identified as Proprietary Information of the disclosing party.

The foregoing shall not apply to any information that the receiving party can show by competent evidence:

- a. Was known to it prior to the disclosure of that information by the disclosing party; or
- b. Is independently developed by or for it without breach of this Agreement by persons who have not been exposed to the Proprietary Information; or
- c. Was publicly available and readily ascertainable in substantially the same form at the time of disclosure, or became publicly available and readily ascertainable in such form without breach of this Agreement; or
- d. Was or is publicly disclosed by the disclosing party, or is rightfully received by the receiving party from a third party, without an obligation of confidentiality; or
- e. Is required by statutory, regulatory, administrative or judicial order or requirement to be disclosed, provided that the disclosing party gives prompt notice of such intended disclosure.

Proprietary Information remains the property of the disclosing party. Upon written request of the disclosing party, the receiving party shall immediately return or destroy the Proprietary Information supplied by the disclosing party, including any and all copies thereof and including all analyses, compilations, summaries, studies and other material prepared by such party or its employees and based in whole or in part on, or otherwise containing or reflecting, any of the Proprietary Information.

It is agreed that receipt from the other party of Proprietary Information does not grant any rights, either expressly, by implication, estoppel, or otherwise to intellectual property or any other right or license, except as specifically set forth herein. No exchange of information by the parties shall operate as a representation, warranty, assurance, guarantee, or inducement by either party to

the other with respect to the infringement of trademarks, patents, copyright, or any rights of privacy, or other rights of third persons.

13. INTELLECTUAL PROPERTY. "Project Intellectual Property" means the legal rights relating to inventions, patent applications, patents, copyrights, trademarks, mask works, trade secrets and any other legally protectable information, including computer software, first made or generated during the performance of the Research. If Sponsor uses federal funds for any payments under this Agreement, rights to data and inventions generated under the Research shall be in accordance with the appropriate federal laws and regulations with the Sponsor having rights in data and inventions as necessary to perform its prime contract. In the absence of federal funding, the following shall apply.

13.1. Ownership of Technology. Virginia Tech owns the entire right, title, and interest, including all patents, copyrights, and other intellectual property rights, in and to all Project Intellectual Property developed by Virginia Tech personnel ("Virginia Tech IP") under this Agreement. Sponsor owns all interests, including all patents, copyrights, and other intellectual property rights, in and to all Project Intellectual Property developed by Sponsor personnel under this Agreement ("Sponsor IP"). Project Intellectual Property that is jointly developed by Virginia Tech and Sponsor personnel will be jointly owned ("Joint IP").

13.2. Disclosure. Virginia Tech and/or VTIP will provide Sponsor with a complete, written, confidential disclosure of any Virginia Tech IP after the disclosure is received by VTIP.

13.3. Patent Filing and Expenses. VTIP may file patent applications at its own discretion and expense, or at the request of Sponsor at Sponsor's expense. If Sponsor elects to exclusively license Virginia Tech IP, Sponsor will pay for the costs of patent filing, prosecution and maintenance in the United States and any foreign country.

13.4. Licenses. For all Joint IP, each Party shall have the independent, unrestricted right to license to third parties any such Joint IP without accounting to the other

Party, except that the Sponsor shall be entitled to request an exclusive license to Virginia Tech's interest in a Joint Invention as provided below.

For all Sponsor IP, Sponsor hereby grants Virginia Tech a non-exclusive, non-transferable, royalty-free license for internal research purposes.

For all Virginia Tech IP, Virginia Tech hereby grants the Sponsor a non-exclusive, non-transferable, royalty-free license for internal research purposes. The Sponsor shall further be entitled to elect one of the following alternatives:

For patentable Virginia Tech IP, the Sponsor may choose:

(a) **a Non Exclusive License.** By notice in writing to Virginia Tech within six (6) months after Virginia Tech and/or VTIP's notification to the Sponsor that a disclosure has been filed and subject to third party rights, if any, a nonexclusive, nontransferable (without the right to sublicense), worldwide license in a designated field of use to make, have made, use, and sell products covered by the patent application on terms to be negotiated. VTIP and/or Virginia Tech may at its option discontinue patent prosecution or maintenance of any invention licensed to Sponsor under this alternative for which VTIP and/or Virginia Tech is paying patent-related costs; or

(b) **an Exclusive License.** By notice in writing to Virginia Tech within six (6) months after Virginia Tech and/or VTIP's notification to the Sponsor that a disclosure has been filed and subject to third party rights, if any, a royalty-bearing, limited-term, exclusive, field-of-use license (subject to third-party rights, if any), including the right to sublicense, in the United States or any other country elected by Sponsor to make, have made, use, and sell products covered by the patent application, in exchange for Sponsor's agreement to diligently commercialize the invention.

For copyrightable Virginia Tech IP, the sponsor may choose by notice in writing to Virginia Tech within six (6) months after Virginia Tech and/or VTIP's notification to the Sponsor that a disclosure has been filed:

a Nonexclusive or Exclusive License. Subject to third party rights, if any, a royalty-bearing license to use, reproduce, display, distribute and perform computer software and its documentation for commercial purposes in a designated field of use. Computer software for which a patent application is filed is subject to terms for patentable Virginia Tech IP.

13.5. License Terms and Conditions. All licenses of this Article 13 elected by Sponsor are effective as of the date the parties negotiate and sign a separate license agreement, which will contain indemnity, insurance, and no-warranty provisions, in addition to other customary terms and conditions. Sponsor agrees all licenses will be subject to any applicable laws and regulations. If the Sponsor and Virginia Tech and/or VTIP fail to enter into a license agreement within three (3) months after the Sponsor's election to proceed under Article 13.4 above, the Sponsor's rights under this article will expire.

13.6. Non-Election. If Sponsor does not provide written notice of election to Virginia Tech within 6 months of a written disclosure under Article 13.4, Virginia Tech and/or VTIP have no further obligations to the Sponsor and may license the Virginia Tech IP to third parties.

13.7. Assignment. In accordance with University Policy 13000, Virginia Tech states that all of its employees, students, and consultants who participate in the Research will be obligated to assign to Virginia Tech all their rights in patentable or copyrightable Intellectual Property.

13.8. Other Intellectual Property. All intellectual property developed outside of this Agreement shall remain the property of its owner. No rights are granted to either party's intellectual property developed outside of this Agreement except as explicitly provided in this Agreement.

14. DISPUTES. The parties shall use all reasonable efforts to amicably resolve disputes arising out of this Agreement, prior to commencing any formal legal proceedings. Such efforts may include use of a mutually agreed alternative dispute resolution mechanism. Pending resolution of any such dispute by settlement or by final judgment, the parties shall proceed diligently with performance.

15. GOVERNING LAW. The validity and interpretation of this Agreement shall be governed by the laws of the Commonwealth of Virginia and the applicable U.S. Federal law. Any legal action involving this Agreement or the Research will be adjudicated in the State of Virginia.

16. FORCE MAJEURE. Neither party shall be responsible to the other for failure to perform any of the obligations imposed by this Agreement, provided such failure shall be occasioned by fire, flood, explosion, lightning, windstorm, earthquake, subsidence of soil, failure or destruction, in whole or in part, of machinery or equipment or failure of supply of materials, discontinuity in the supply of power, governmental interference, civil commotion, riot, war, strikes, labor disturbance, transportation difficulties, labor shortage or any other conditions of whatsoever nature or description beyond their reasonable control.

17. EXPORT AND SANCTIONS COMPLIANCE. It is understood that both parties are subject to U.S. export control laws and regulations including but not limited to the International Traffic in Arms Regulations (“ITAR”, 22 CFR 120-130) and the Export Administration Regulations (“EAR”, 15 CFR 300-799). Export-controlled “Items” are hereby defined as defense articles, technical data, or defense services subject to the ITAR or any technology or source code controlled under the EAR. Both parties acknowledge that Virginia Tech is a public university and there exists a likelihood that Virginia Tech faculty and/or students involved in fulfilling this agreement may be foreign persons (22 CFR 120.16 and 15 CFR 772). As such, Virginia Tech requires written notification to Virginia Tech’s Office of Export and Secure Research Compliance at oesrc@vt.edu prior to the exchange of any export-controlled Items. Parties agree to provide a description of the Items and export

control classification. Virginia Tech shall have the right to decline or limit the receipt of such Items, and any task requiring receipt of such Items. The transfer or release of export-controlled Items may require a license from the cognizant agency of the U.S. government. The parties agree to cooperate in securing any license which the cognizant agency deems necessary in connection with this Agreement.

It is understood that both parties are subject to U.S. sanctions executive orders, laws and regulations controlling transactions of goods and services with sanctioned or embargoed countries, entities, and individuals (“denied parties/persons”), which includes but are not limited to persons or entities designated as U.S. Treasury Department Specially Designated Nationals List, Department of Commerce Entity List, Denied Persons List, Unverified List, and U.S. Department of State Debarred List. Each party will take reasonable steps to ensure that no goods or services are exported or imported to denied parties/persons without proper authorization from the cognizant agency.

18. INDEPENDENT CONTRACTORS. Virginia Tech and Sponsor are independent contractors. Neither is an agent, joint venture participant, or partner of the other.

19. NON DISCRIMINATION. Virginia Tech shall follow its normal employment policies and Virginia State law, which prohibit discrimination against any employee or applicant for employment on the basis of race, color, creed, religion, national origin, sexual preference, marital status, age, sex, or handicap (except where bona fide occupational qualification so requires), with respect to this Agreement. Qualified individuals will not be denied the opportunity to contribute to the work to be conducted at Virginia Tech under this Agreement on those bases or on the basis of citizenship.

20. SEVERABILITY. All provisions of this Agreement shall be applicable only to the extent that they do not violate any applicable law, and are intended to be limited to the extent necessary so that they will not render this Agreement invalid, illegal or unenforceable under any applicable law. If any provision of this Agreement

shall be held invalid, illegal or unenforceable, the validity, legality or enforceability of other provisions of this Agreement shall not be affected thereby.

21. WAIVER OF RIGHTS. No waiver of any right or remedy hereunder by either of the parties shall be deemed to be a waiver of any other right or remedy of any subsequent right or remedy of the same kind.

22. ASSIGNMENT. This Agreement shall be binding upon and inure to the benefit of the parties hereto and the successors to substantially the entire business assets of the respective parties hereto. This Agreement shall not be assignable by either party without the prior written consent of the other party; any attempted assignment is void.

23. USE OF NAMES. Neither party will use the name of the other in any advertising or make any form of representation or statement in relation to the Research which would constitute an express or implied endorsement of any commercial product or service without first having obtained written permission of the other Party.

24. PREVAILING TERMS. In the event of any inconsistency between the terms of this Agreement and the documents referenced or incorporated into this Agreement, the terms of this Agreement prevail.

25. ENTIRE AGREEMENT. This Agreement represents the entire agreement and understanding between the parties with respect to its subject matter. It supersedes all prior or contemporaneous discussions, representations, or agreements, whether written or oral, of the parties regarding this subject matter.

26. ELECTRONIC SIGNATURES. The parties to this Agreement agree that a copy of the original signature (including an electronic copy) may be used for any and all purposes for which the original signature may have been used. The parties further waive any right to challenge the admissibility or authenticity of this Agreement in a court of law based solely on the absence of an original signature.

27. COUNTERPARTS. This Agreement and any amendment to it may be executed in counterparts and all of these counterparts together shall be deemed to constitute one and the same agreement.

28. NOTICES. Any notice or other communication of the parties required or permitted to be given or made under the Agreement will be in writing and will be deemed effective when sent in a manner that provides confirmation or acknowledgement of delivery and received at the address set forth below or by email to the email address provided below.

For: Virginia Tech
To: John Rudd
Address: North End Center, Suite 4200
300 Turner Street NW
Blacksburg, VA 24061
Email: ruddj@vt.edu

For: SPONSOR
Address: City of Fresno
Attention: Thomas C. Esqueda
2600 Fresno Street
Fresno, CA 93721
Email: thomas.esqueda@fresno.gov

*****SIGNATURE PAGE FOLLOWS*****

IN WITNESS WHEREOF, the parties have caused the Agreement to be signed below by their duly authorized representatives on the day and year set forth below.

VIRGINIA TECH

BY: *Lauren P. Maguire for*

Name: John Rudd

Title: Assistant Vice President of Sponsored Programs Administration

Date: 09/09/2016

SPONSOR

City of Fresno, a California municipal corporation

BY: _____

Name: Thomas C. Esqueda

Title: Director of Public Utilities, City of Fresno

Date: _____

ATTEST:

BY: _____

Name: Yvonne Spence, CMC

Title: City Clerk, City of Fresno

Date: _____

APPROVED AS TO FORM:

Douglas T. Sloan, City Attorney

BY: *[Signature]*

Name: Katie Doer

Title: Chief Assistant City Attorney

Date: 9/9/16

ADDRESSES

Virginia Tech
Attention: Dr. Marc Edwards
407 Durham Hall
Blacksburg, VA 24061
Phone: 540-231-7236

ADDRESSES

City of Fresno
Attention: Thomas C. Esqueda
2600 Fresno Street
Fresno CA 93721
Phone: 559-621-8610
FAX: 559-498-1304

SCOPE OF RESEARCH INVESTIGATION
Bench Scale Testing Program
Galvanized Pipe Corrosion Control Treatment Optimization

BACKGROUND

In January 2016, the City of Fresno (City) received reports of discolored water in Northeast Fresno (NE Fresno), and the City immediately initiated a discolored water investigation to determine the source and cause of discolored water occurring in premise plumbing in single-family residential homes. The area reporting discolored water is generally bounded by Copper Avenue to the north, Willow Avenue to the east, State Route 41 to west, and Herndon Avenue to the south (See Map). Within this bounded area, there are approximately 22,500 homes, and the City has received reports of discolored water from approximately 1,500 homes. The City has the flexibility to serve this area with surface water from Pine Flat Reservoir and Millerton Lake and with groundwater from a number of public water supply wells located in NE Fresno. Chemically, the surface water can be characterized as “soft” water, and the groundwater can be characterized as “hard” water.

Within the NE Fresno area, the City’s water distribution system is operated to maintain a system pressure in the range of 50 to 60 pounds-per-square-inch (psi). The City’s water supply strategy for NE Fresno is to operate the surface water treatment plant at a relatively constant flow rate to meet baseline demands. As the pressure in the distribution system decreases in response to increasing demands, the SCADA system energizes groundwater wells to increase the flow and pressure to the system to supplement the baseline water supply from the surface water treatment plant. Under this operating strategy, some residents in NE Fresno can receive a blend of surface water and groundwater throughout the day as system demands change with a normal diurnal pattern.

The City’s investigation has included water quality sampling at residential homes, site visits and inspections at residential homes, as well as plumbing material testing and soil material testing at residential homes. To date, the City has received water quality testing data for 554 homes. Based on the City’s interpretation of the water quality testing data, the City has determined that the source of discoloration is the corrosion of galvanized pipe within single-family residential homes. Further, the City’s investigation and water quality data has determined that the appearance of red water in homes with galvanized pipe appears to be more pronounced in hot water and after periods of stagnation.

PURPOSE

In accordance with the federal and state requirements of the Safe Drinking Water Act, the City is required to deliver water to the taps of customers that is deemed to be “non-corrosive”. For the purposes of regulatory compliance, the City is deemed compliant with the “non-corrosive” standard, if the City complies with the testing and reporting requirements of the Lead and Copper Rule (LCR). The City has been conducting LCR sampling and testing since 1993, and has collected approximately 730 samples since program inception, and during that period only 8 samples had a reported value greater than the Lead Action Level of 15 ug/L.

SCOPE OF RESEARCH INVESTIGATION

Bench Scale Testing Program

Galvanized Pipe Corrosion Control Treatment Optimization

While the City has been fully compliant with the requirements of the LCR, and the system has been optimized for reduced lead and copper corrosion, the presence of galvanized pipe corrosion in NE Fresno is a concern for the City. It is the City's desire to determine the technical feasibility of developing a water chemistry that can be applied at the City's surface water treatment plant to also reduce the incidence of galvanized pipe corrosion problems in a system that receives both surface water and groundwater. Accordingly, the City has determined that there is a need to commission a research project with Dr. Marc Edwards of the Virginia Polytechnic Institute and State University (Virginia Tech) to research and identify alternative water chemistry options that may be suitable to implement at the City's surface water treatment plant to reduce the rate of galvanized pipe corrosion.

The scope of the research investigation is described in the following sections.

SCOPE OF RESEARCH INVESTIGATION

Dr. Edwards and his research team have previously conducted research on the corrosion of galvanized pipe. It is expected that the research and findings resulting from this project will add to, and enhance, what is currently known about optimizing water treatment processes to reduce the corrosion of galvanized pipe in a residential plumbing system that receives a blend of surface water and groundwater.

Task 1 – Work Planning and Project Management

This Task will be allocated to Virginia Tech to plan, coordinate, and manage the logistics required to conduct the bench scale tests to be conducted in Task 3, and to provide overall management and administration of the research project.

The deliverable for this Task will be periodic progress reports on the activities associated with the research project.

Task 2 – Identification of Alternative Bench-Scale Testing Options

For this research project, Virginia Tech will conduct a series of bench scale tests (beaker tests, jar tests) of different water chemistry options optimized for galvanized pipe corrosion for hot water conditions, cold water conditions, and stagnation conditions. Prior to initiating the bench scale tests, Virginia Tech and the City will work together to review, evaluate, and agree upon the purpose and objective of the bench scale testing program; the means, methods, duration, and approach for conducting the bench scale tests; the range of chemistry options to conduct at bench scale; and a final list of water chemistry options to conduct at bench scale.

The deliverable for this Task will be a brief letter report summarizing the agreed upon goals and objectives; the means, methods, duration, and approach for conducting the bench scale tests; and the final list of water chemistry options to be conducted at the bench scale.

SCOPE OF RESEARCH INVESTIGATION
Bench Scale Testing Program
Galvanized Pipe Corrosion Control Treatment Optimization

Task 3 – Conduct Bench-Scale Testing of Alternative Water Chemistry Options

For this Task, Virginia Tech will conduct the mutually-agreed upon bench scale tests as defined in the brief letter report prepared for Task 2. The objective of this Task will be to test a series of alternative water chemistry options optimized for galvanized pipe corrosion for hot water conditions, cold water conditions, and stagnation conditions. As will be described in the Task 2 letter report, it is anticipated that this series of bench scale tests will include testing for varying combinations of the following:

- a) Alternative types and blends of corrosion inhibitors (phosphate products);
- b) Alternative chemicals to adjust pH, alkalinity, and hardness;
- c) Alternative ranges of pH, alkalinity, and hardness;
- d) Alternative ratios of groundwater and surface water blending;
- e) Alternative water temperatures; and
- f) Alternative periods of stagnation

For this Task, the City will assume the responsibility to obtain and ship galvanized pipe samples, surface water samples, and groundwater samples to Virginia Tech to conduct the bench scale tests.

The deliverable for this Task will be the conduct of the bench-scale testing. The findings of the bench scale testing will be presented in interim, draft and final reports prepared under Task 4.

Task 4 – Prepare Reporting on Findings of Bench-Scale Testing

As individual bench scale tests are completed in Task 3, Virginia Tech will document the findings and results of the tests in the form of interim reports that will be transmitted to the City for review. Upon completion of the bench scale testing program, the interim reports will be consolidated into a Draft Report for submittal to the City for review and comment. The Draft Report will have the following sections:

- I. Introduction
- II. Background
- III. Research Purpose and Objective
- IV. Description of Bench Scale Testing Method and Approach
- V. Description of Bench Scale Tests

SCOPE OF RESEARCH INVESTIGATION
Bench Scale Testing Program
Galvanized Pipe Corrosion Control Treatment Optimization

- VI. Findings of Bench Scale Tests
- VII. Recommendations for Demonstration-Scale Pipe Loop Testing

Appendices

Interim Reports of Bench Scale Test Results

The City will be provided with two weeks to review the Draft Report, and provide written comments to Virginia Tech for consideration. Upon receiving the City's review comments, Virginia Tech will incorporate the City's comments into a Final Report. The Final Report will be submitted to the City in hard-copy format (10 copies) and one digital copy format (PDF).

Task 5 – Onsite Inspections, Investigations, and Meetings

This Task will be allocated to Virginia Tech to allow members of the research team to travel to the City of Fresno to meet with City representatives as needed to review and discuss the purpose and objective of the research project; finalize the bench scale testing plan; present the findings and recommendations of the bench scale testing program; and participate in the planning and design of the demonstration-scale pipe-loop testing program.

