Best Management Practices for Aboveground Storage Tanks

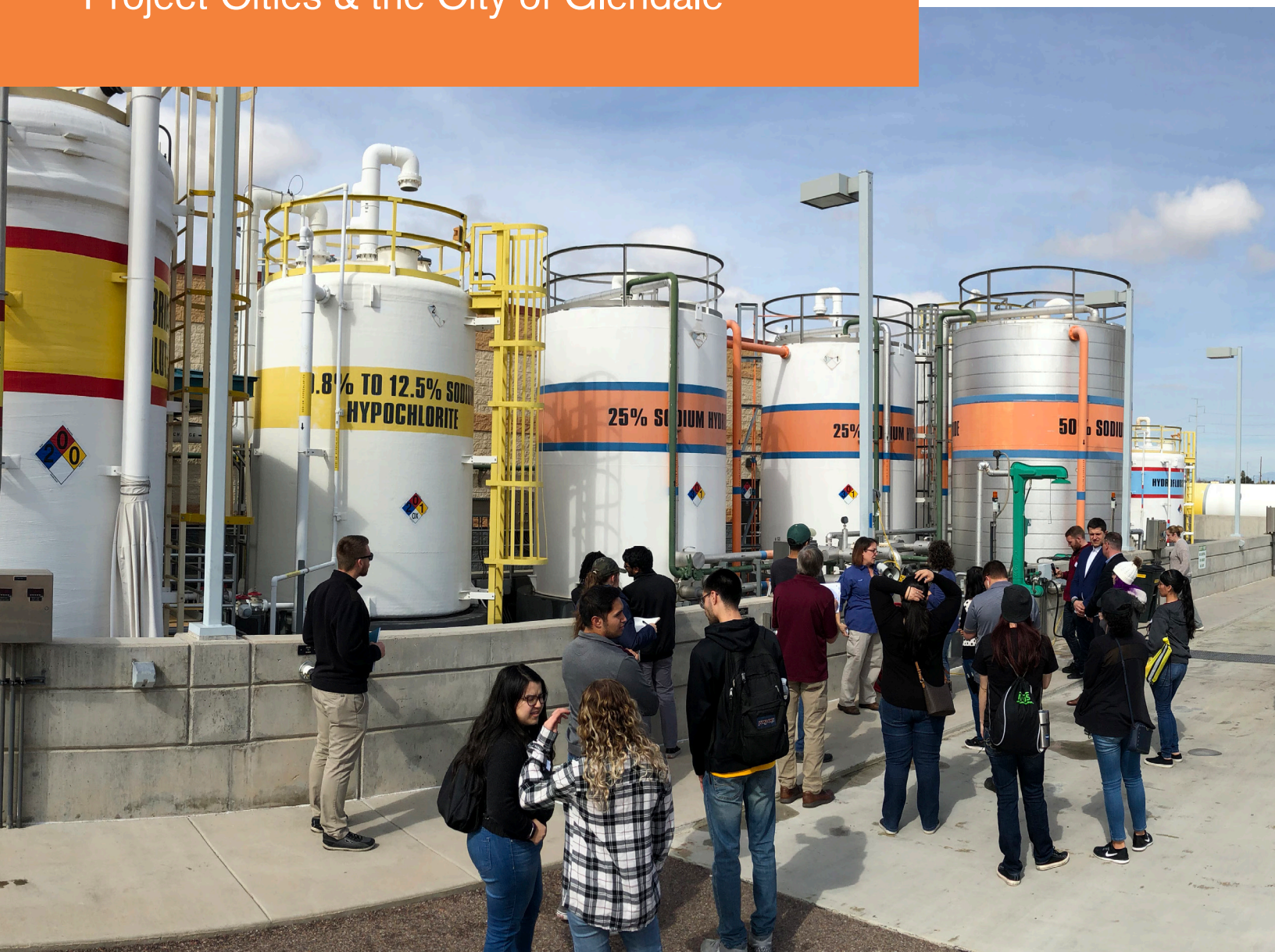
A Spring 2019 Collaborative Report with Arizona State University's Project Cities & the City of Glendale

Sustainable Cities Network

Arizona State University

Project Cities

Glendale ARIZONA



This report represents original work prepared for the City of Glendale by students participating in courses aligned with Arizona State University's Project Cities program. Findings, information, and recommendations are those of students and are not necessarily of Arizona State University. Student reports are not peer reviewed for statistical or computational accuracy, or comprehensively fact-checked, in the same fashion as academic journal articles. Project partners should use care when using student reports as justification for future actions. Text and images contained in this report may not be used without permission from Project Cities.

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ACKNOWLEDGMENTS

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On behalf of the ASU Wrigley Institute and the School of Sustainability, we extend a heartfelt thank you to the City of Glendale for enthusiastically engaging with students and faculty throughout the semester. These projects provide valuable real-world experience for our students and we hope that their perspectives shine light on opportunities to continuously improve Glendale's future livelihood and community well-being.

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To access the original student reports, additional materials, and resources, visit:
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ABOUT PROJECT CITIES

Arizona State University's (ASU) Project Cities program is a university-community partnership. For an entire academic year, faculty and students work with a single city to co-create strategies for better environmental, economic, and social balance in the places we live. Students from multiple disciplines research difficult problems chosen by the city and propose innovative sustainability solutions. Project Cities is a member of the Educational Partnerships for Innovation in Communities Network (EPIC-N), a growing network of more than 30 educational institutions partnering with cities throughout the United States and the world.

ABOUT SUSTAINABLE CITIES NETWORK

Project Cities is a program of ASU's Sustainable Cities Network. This network was founded in 2008 to support communities in sharing knowledge and coordinating efforts to understand and solve sustainability problems. It is designed to foster partnerships, identify best practices, provide training and information, and connect ASU's research to front-line challenges facing local communities. Network members come from Arizona cities, towns, counties, and Native American communities, and cover a broad range of professional disciplines. Together, these members work to create a more sustainable region and state. In 2012, the network was awarded the Pacific Southwest Region's 2012 Green Government Award by the U.S. EPA for its efforts. For more information, visit *sustainablecities.asu.edu.*

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Project Cities

Sustainability Through Local Action

projectcities.asu.edu

ABOUT GLENDALE

The City of Glendale is located in Maricopa County, roughly nine miles northwest of Downtown Phoenix. Glendale's population is about 250,000, comprised of diverse communities, including large Hispanic populations, retirement communities, local businesses, and event-goers. Glendale is home to attractions such as the State Farm Stadium, Westgate Entertainment District, the Gila River Arena, Glendale Community College, and the ASU West Campus. With abundant attractions and temperate climate, Glendale has something to offer for its residents and tourists all year round. In August 2016, 71% of voters supported Envision Glendale 2040, a plan that signaled the City's commitment to sustainability. Glendale has chosen to pair up with Project Cities to find new ways to promote sustainability and engage with their communities to better serve their diverse needs.

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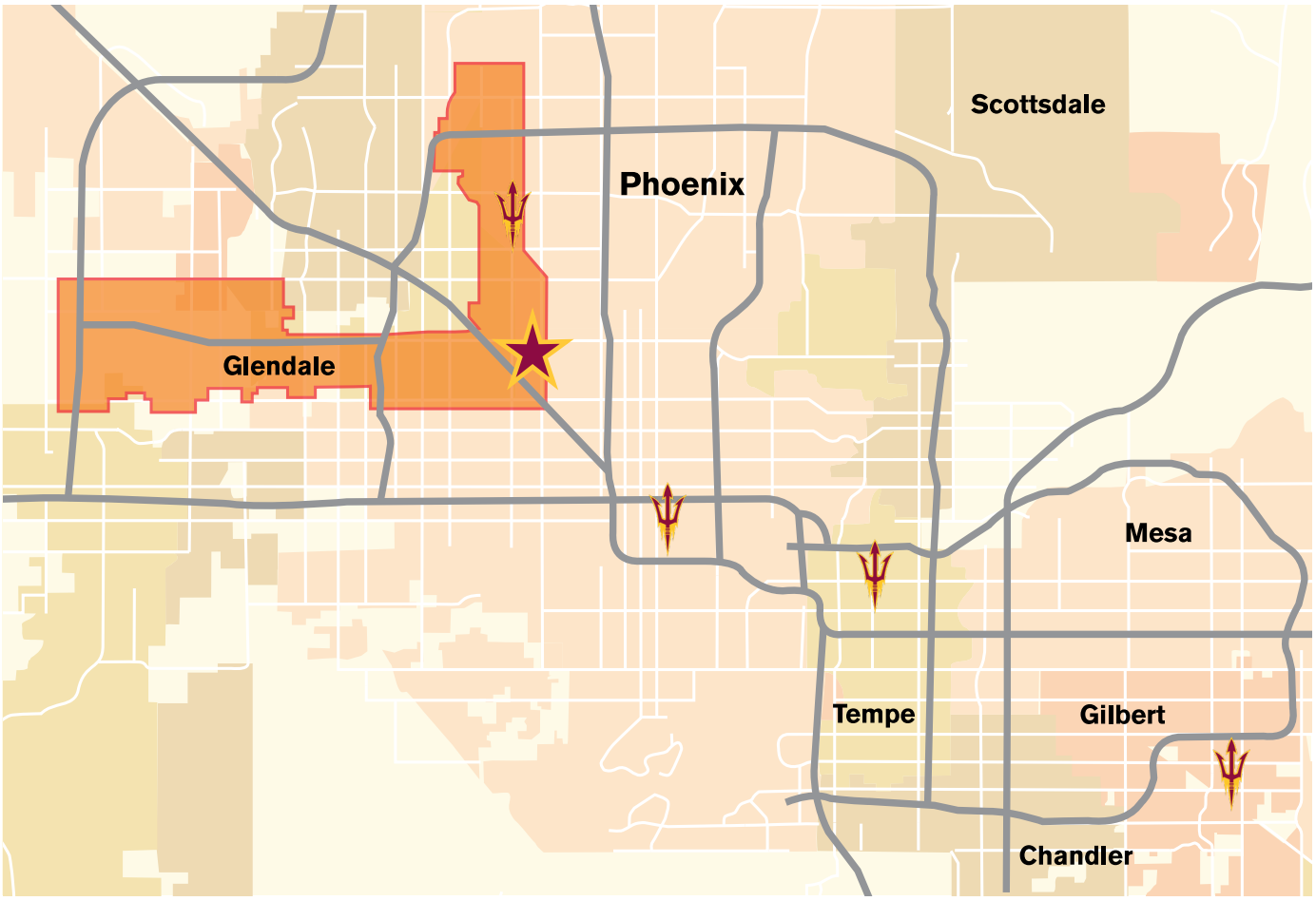
MAP OF GLENDALE & GREATER PHOENIX, ARIZONA



A Message from the City Manager

In 2018, the City of Glendale entered into a partnership with Arizona State University to participate in the Project Cities Program. The goal of this program is to deliver sustainability research, education, and solutions with practical, measurable and meaningful impact to local government. It is a university-community partnership in which ASU students work on research projects that will inform programs or services related to the city's strategic objectives and which have a sustainability component. These projects may include co-creating implementation frameworks or solution pathways for environmental, economic, or social improvement projects all of which will help Glendale prepare for the future.

The leadership team and I can proudly say that ASU's Project Cities program has provided a value-added experience for our staff and fulfilled the need for research on key organizational issues. We have been extremely impressed with the professionalism and relationships our city has developed with the students and ASU's Project Cities staff. They have brought a fresh and unique perspective to challenges that affect our city.

The projects chosen are aligned to the City of Glendale's mission and values and are intended to help advance several of our strategic objectives, initiatives, and existing programs. We specifically sought to gain insights around communication to include social media management and multi-generational engagement, as well as sustainable asset management for the city fleet, facility master plan, and above ground chemical storage tanks.

This valuable experience has been a tremendous learning opportunity for our city as well as for the dedicated students who exhibited their unique skill set. One of the surprising benefits has been for our staff liaisons who were refreshed and invigorated through their interactions with the next generation of leaders, and found the students to be very thoughtful, intelligent, and inquisitive. The opportunity to expose students to potential careers in local government also aids in developing a pipeline of future talent in local government.

In closing, we truly strive to improve the lives of the people we serve every day and these projects have provided us with insights that will help guide actions and future recommendations for our City Council. We are excited about the strategic direction for Glendale and have set the bar high for success. We feel extremely fortunate to have experienced a great partnership through the ASU Project Cities program which will play an integral role in achieving our goals.

Sincerely,

Kevin R. Phelps
City Manager
5850 W. Glendale Avenue, Glendale, AZ 85301
623.930.2870

The following report summarizes and draws highlights from work and research conducted by students in ERM 401/501 and EGR 427 Hazardous Waste Management, for the Spring 2019 partnership between ASU's Project Cities and the City of Glendale.

To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCGlendaleStorageTanks

EXECUTIVE SUMMARY

From water treatment to backup power generation for fire departments and police stations, Aboveground Storage Tanks (ASTs) are used to store a range of chemical agents necessary to a wide variety of local governmental functions. For this reason, it is critical that cities use and maintain ASTs efficiently and safely for their residents, the environment, and public health. The City of Glendale has committed to become a regional leader in AST management to ensure safety, eliminate pollution risks, and adhere to best practices. In this spirit, Glendale partnered with ASU to conduct a comprehensive overview of regulations and standards that apply to various ASTs.

Students in ERM 401/501 and EGR 427 Hazardous Waste Management spent the Spring 2019 semester researching compliance standards and regulatory requirements for better AST management, as well as identifying best practices to help Glendale's staff develop an effective and efficient operations and maintenance (O&M) program for their approximately 135 ASTs. Students were from ASU's Polytechnic campus, Tempe campus, and the ASU online program. Each group of students addressed a different need for the City's compliance program through three course projects.

Regulations and Standards: The City of Glendale manages several ASTs that are not covered by Resource Conservation and Recovery Act (RCRA) or Spill Prevention, Control and Countermeasure (SPCC) requirements. However, standards and procedures in practice at other professional organizations can help to guide Glendale's compliance program. The online student group investigated inspection checklists and schedules from the Steel Tank Institute (STI) and the American Petroleum Institute (API), two of the leading inspection programs in the industry. Students then created a list of recommendations of permit conditions, tank O&M plans, and inspection requirements.

Benchmarking: The Polytechnic campus group conducted interviews and outreach, and otherwise researched a variety of other organizations, to identify the best practices, providing Glendale with a suite of options to further refine into a model for compliance and O&M planning. Their research focused on three categories: large industrial companies, transportation companies, and cities/tribes.

Editor's Note
This report frequently refers to industry publications and utilizes some professional jargon. To assist the reader, a glossary has been compiled and is provided at the end of this report. The glossary can be found on page 58.

Fuel Tank Proposal: Backup generators ensure that cities can maintain critical services (such as water treatment) in the event of a prolonged power outage, but diesel fuel degrades over time, posing a unique management challenge. Diesel is not cheap, and extreme heat experienced during the summer in Glendale accelerates the degradation of fuel quality, therefore a fuel-tank program that fits the City's budget and climate is crucial. The Tempe campus group researched industry standards and government regulations around fuel storage, to develop recommendations for Glendale's fuel tank compliance and O&M program. To begin, students reviewed AST practices used by similar cities and their associated costs.

Figure 1 *Students participate in a site visit to Glendale's Oasis Water Treatment Plant*

GOALS & RECOMMENDATIONS

The students' research aims to: 1) develop a new AST maintenance program; 2) create an O&M plan that minimizes employee exposure to hazardous chemicals and flammables; and 3) ensure that the diesel fuel stored for emergency power generation is monitored and kept for its specified use.

Figure 2 *Students attend a workshop by one of Glendale's current AST management contractors, prior to touring the Oasis Water Treatment Plant*

Figure 3 *Students examine a number of Glendale's existing ASTs at the Oasis Water Treatment Plant*

RECOMMENDATIONS FOR ADVANCED ABOVEGROUND STORAGE TANK MANAGEMENT

Regulations & Standards Recommendations
Ensure facilities comply with permit and renewal conditions and submit timely revisions as necessary (Schneider et al., p.14).
Facilities meeting the applicability standards of the International Fire Code should submit Hazardous Materials Management Program (HMMP), Hazardous Materials Identification System (HMIS), and all Safety Data Sheets (SDSs) to the City's Fire Marshal Hazardous Materials Unit, and ensure permits are renewed on time (Schneider et al., p.14).
Ensure facilities follow Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HazWOpER) requirements to prevent and contain spills, as detailed in 29 CFR 1920 Subpart H (Schneider et al., p.17).
Facilities using hazardous materials must also keep appropriate SDSs and an HMIS on site, following OSHA requirements (Schneider et al., p.15).
Tanks containing flammable/combustible liquids, as well as those containing over 1,320 gallons of potentially toxic materials should have overfill protections (specified by NFPA 30) according to manufacturer's instructions (Schneider et al., p.16-17).
Ensure the facility staff inspect ASTs regularly following the STI and/or API inspection schedule. Use criteria checklists to ensure proper tank cleanliness, usability, and safety. Include API STD 653's recommendations for thickness calculations and recording corrosion extent during scheduled inspections (Schneider et al., p.23-24).
Familiarize facility supervisors with protocols for tank entry/cleaning and ensure outside contractors are following OSHA and NFPA 326 requirements (Schneider et al., p.18-19).

RECOMMENDATIONS FOR ADVANCED ABOVEGROUND STORAGE TANK MANAGEMENT (CONT'D)

Benchmarking Recommendations
Conduct routine visual inspections every 72 hours, including an inspection of grass surrounding storage tanks as an indicator for leak detection (Kemp et al., p.29).
Conduct complete inspections at least monthly to ensure consistent functioning and optimal structural integrity of the tank (Kemp et al., p.30).
Require mandatory reporting of any upgrade, change in use, or tank replacement within 30 days (Kemp et al., p.29).
Compile Standard Operating Procedure (SOP) best practices and industry standards into a comprehensive guide (e.g., Air Force Manual (AFMAN), Army Regulations, ESOP) that includes checklists for daily/weekly/monthly/annual timeframes. Update guide annually, tailored to the specific facility where an AST is situated (Kemp et al., p.29).
In accordance with industry standards, keep records for at least three years. However, to provide a better baseline of documentation throughout the lifetime of the tank, we recommend that Glendale retain records for five years (Kemp et al., p.30).
Conduct annual employee training (Kemp et al., p.29).
Monitor pollution, i.e., vapors in soil and groundwater (Kemp et al., p.29).
Use double-wall ASTs whenever possible and practice regular interstitial monitoring of tanks (Kemp et al., p.29).
Develop specific standards for storage and containment areas, including provisions for outdoor storage and secondary containment wall height (Kemp et al., p.29).
In addition to structural integrity, special attention should be paid to the premises guarding the tank, spill protocols, and contained substances (Kemp et al., p.30).
Because diesel fuel degrades in the Phoenix metro area after about six months, inspections should occur monthly or quarterly (Kemp et al., p.30).
To maintain a healthy management system for ASTs, implement a mandatory SOP for all facilities that have ASTs (Kemp et al., p.31).
Recordkeeping and compliance should be specifically delegated to a responsible person within city government to maintain compliance with regulations and adherence to best industry practices. Proper management of ASTs will mitigate risks to public health and the environment (Kemp et al., p.31).

RECOMMENDATIONS FOR ADVANCED ABOVEGROUND STORAGE TANK MANAGEMENT (CONT'D)

Benchmarking Recommendations (Continued)
All tanks within the City of Glendale should comply with the Fire Department Inspection Code 450, titled 'Storage and Use of Flammable Liquids' which details that a permit is required for the storage of flammable and combustible liquids (Glendale Fire Department) (Kemp et al., p.30).
The liquids must be contained within approved containers that are properly labeled and include the appropriate hazard signs (Kemp et al., p.30).
Tanks holding flammable materials that are located in buildings should be inspected to verify the absence of ignitable vapors when construction activities are conducted inside the building (Kemp et al., p.30).
Compliance with the SOP should be specifically delegated to an organizational unit in charge of regulating the tank (Kemp et al., p.30).
Consider following the suggested SOP, Inspection Checklist and Inspection Log that were developed by the students. (See Appendix Q of Kemp et al., p.30, provided in the digital project folder.)

RECOMMENDATIONS FOR ADVANCED ABOVEGROUND STORAGE TANK MANAGEMENT (CONT'D)

Fuel Tank Program Recommendations
Refer to manufacturer's instructions and the tank construction standard to determine correct inspection schedules (Callender et al., p.16).
Refer to the tables in the analysis section to determine testing criteria for each tank, which must be evaluated individually. Determine the testing criteria based on manufacturer's recommendations, fabrication/installation methods (shop vs. field-erected), material, size, and specific gravity of the contained substance (Callender et al., p.16).
Use STI-SP001 for inspection standards for diesel fuel in ASTs (Callender et al., p.16).
Calculate total oil storage capacity annually to ensure compliance with SPCC rules, which only apply when the total aboveground oil storage capacity is >1,320 gallons. Though this plan is intended for fuel tanks that are <1,320 gallons, the total amount of fuel at each facility should be regularly calculated (Callender et al., p.16).
Provide general secondary containment material such as absorbents near areas where oil or chemical spills occur (most commonly during the transfer between containers). Rapid containment will prevent contamination of water sources (Callender et al., p.16).
Use non-flammable containers for fuel storage. This includes material such as steel alloys (Callender et al., p.16).
Perform routine maintenance inspections, including quarterly fuel maintenance. The fuel contractor should implement a six-month visual testing; the City should supplement contractor inspections with more frequent staff inspections (Callender et al., p.16).
Verify that removed wastes are properly disposed (Callender et al., p.17).
Keep a record of all maintenance activities and inspections (Callender et al., p.17).
Per EPA Power Resilience Guide, "…when you change the oil in your generator, consider sending a sample to be tested for the presence of metals. Metals could indicate engine wear, which may indicate that other repairs are needed." Ensure optimal performance in case of an emergency (Callender et al., p.17).
The City should turn on and test backup fuel generators every six months to ensure stability and performance efficiency in case of an emergency (Callender et al., p.17).
Replace diesel fuel at least once a year, especially after the summer months due to the high heat and possible infiltration of dust and water (Callender et al., p.17).

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FACULTY
AL BROWN

ERM 401/501 & EGR 427: HAZARDOUS WASTE MANAGEMENT
IRA A. FULTON SCHOOLS OF ENGINEERING

Best Management Practices for Aboveground Storage Tanks

Abating Spill Risk to Prevent Pollution and Ensure Safety for Glendale Employees and Residents, through a Consolidated AST Management Plan

ACKNOWLEDGMENTS

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INTRODUCTION

Municipalities use chemicals/fuels to perform a variety of critical tasks, including water treatment, emergency power generation, landscaping, and fueling municipal fleets. They must also store and handle potentially dangerous chemicals and fuels in Aboveground Storage Tanks (ASTs), so it is critical that these substances are managed safely and diligently. Experts in Glendale describe a somewhat disjointed patchwork of regulations and lack of cohesive standards in the industry. The City is working to serve as leaders to ensure safety, eliminate risks of environmental pollution, and adhere to best practices among peers. Glendale has teamed with Project Cities to identify best practices for AST management. For their Project Cities challenge, ERM 401/501 and EGR 427 students were tasked with improving Glendale's AST program to ensure compliance with regulatory frameworks and adherence with municipal best practices.

RESEARCH METHODS

The students began their research with in-person site visits to the City's Oasis Water Treatment Plant, Glendale Municipal Airport, West Area Water Reclamation Facility, Public Safety Training Center, and Municipal Landfill. During these visits, students participated in a workshop with the AST service contractor, toured and assessed the state of Glendale's ASTs, and interviewed experts on the City's maintenance and safety protocols. Students then identified and analyzed current standards, permits, codes, and best practices of AST organizations such as the Steel Tank Institute (STI), American Petroleum Institute (API), National Fire Protection Agency (NFPA), and the City's own internal protocols. The ASU course used an innovative, virtually augmented, multi-campus format. For efficient coordination, students split into three groups, based on their ASU campus (Online, Tempe, Polytechnic), each addressing a separate research question, pertinent to the needs of Glendale's AST program:

1. **What are examples of existing regulations and standards for ASTs that may be applicable to Glendale's program?**
2. **Are there comparable AST management programs that can be used for best practices?**
3. **How can Glendale create an AST program that works with their inventory, budget, and local desert climate?**

REGULATIONS AND STANDARDS FOR ABOVEGROUND STORAGE TANKS

Topic Overview

Students in Senior Lecturer Al Brown's online format course spent the Spring 2019 semester researching best practices from other communities and private entities for the safety and management of aboveground chemical storage tanks (ASTs). Most AST programs across the country use the Clean Water Act Spill Protection Control and Countermeasure (SPCC) and Resource Conservation and Recovery Act (RCRA) regulations to ensure that ASTs are safely managed while protecting the environment and human well-being. Although these regulations set the standard for spill prevention and hazardous waste management, not all AST types are included under SPCC and RCRA regulations, and many facilities and tanks store hazardous materials in their ASTs that are not required to have SPCC plans.

The City of Glendale has SPCC plans in place for facilities that store a total of over 1,320 gallons of petroleum products in ASTs. When hazardous waste is placed in a tank, the tank is regulated by RCRA; however this does not apply to Glendale because the City does not currently store any hazardous waste in ASTs.

Some of Glendale's tanks are not currently regulated by Glendale city code, SPCC or RCRA, but must be properly managed to prevent spills or accidental releases. Examples of the ASTs within Glendale that are not governed by the SPCC or RCRA contain products such as ferric chloride, sodium hypochlorite (bleach), hydrofluosilicic acid, and hydrogen peroxide.

There are over 135 known ASTs that contain 55 gallons or more of hazardous materials. With so many tanks in Glendale, city staff seeks assistance in researching the various regulations, standards, and guidance for ASTs to compile a consolidated resource guide of storage tank management program guidelines that will protect both people and the environment. Within this guide, students provided Glendale with a draft Standard Operating Procedure (SOP) resource guide for its ASTs excluded from SPCC and RCRA regulations. This section of the report:

- **explains AST regulations and standards,**
- **discusses the students' findings of supplemental AST guidance,**
- **and proposes a draft for an AST SOP to ensure compliance and safe management.**

This project excludes underground storage tanks, which are well-regulated at federal and state levels, and compressed gas tanks. The students' research and analysis did not guarantee an exhaustive list, but offer insights to improve Glendale's AST program.

Research Findings & Analysis

The City has three water treatment plants (WTPs): Oasis WTP, Cholla WTP, and Pyramid Peak WTP; and two water reclamation facilities (WRFs): Arrowhead WRF and West Area WRF. The City also has a field operations service center, landfill, and airport. Each location houses several ASTs containing chemicals of varying degrees of hazard to people and the environment:

Notable ASTs in Glendale
Four ~13,000-gallon tanks of 50% sodium hydroxide and 25% sodium hydroxide
One 15,200-gallon and two 17,500-gallon tanks containing aluminum sulfate
Three ~5,000-gallon tanks containing hydrofluosilicic acid
Two 12,000-gallon tanks containing ferric chloride
Two 5,800-gallon tanks containing ferrous chloride
Two 12,500-gallon tanks containing sodium bisulfite

Table 1 *Notable ASTs in Glendale, AZ*

Guest Speaker Eric Brachman, NACE Certified Inspector, Certified Protective Coating Specialist

Brachman is a National Association of Corrosion Engineers Certified Inspector and a Certified Protective Coating Specialist. He inspects water storage tanks at Glendale WTPs and informed students that **most tank failures are due to corrosion caused by oxygen, temperature, salts, pollutants and acid gas**. Corrosion control is an important component of tank inspections; coatings such as paints, glues, and sealants are used to prevent corrosion. Brachman also stated that **46% of all coating failures are due to application error.** For example, an incomplete application could leave small gaps or missed areas, allowing for corrosion. National Sanitation Foundation (NSF) / American National Standards Institute (ANSI) Standard 61 is used to regulate all coatings inside potable water tanks.

Permits

Glendale's WTPs and WRFs must comply with regulations such as the OSHA Hazardous Waste Operations and Emergency Response (HazWOpER), the Clean Air Act, ADFFM, the Fire Department, and annual reports (e.g., EPCRA). See Glossary of Terms on page 58 for more information on these AST regulations.

Pyramid Peak's Fire Department Permit for Flammable/Combustible Liquids does not list an expiration date, nor is a renewal timeline given. However, most other permits do have an expiration date. Glendale has a responsibility to renew its permits in a timely manner. Pyramid Peak WTP's Hazardous Materials Permit (2018) is required by the International Fire Code and annual renewal of the permit is mandatory. This permit also requires the submission of a Hazardous Materials Management Plan (HMMP), a Hazardous Materials Inventory Sheet (HMIS), and Safety Data Sheets (SDS). It should be noted that the Pyramid Peak WTP is located in the City of Phoenix. Fire safety permit administration for the Pyramid Peak WTP requires communications with the City of Phoenix.

The Maricopa County Air Quality Permit to Operate and/or Construct (2017 and 2015, respectively) are two permits in which Arrowhead WRF and Cholla WTP operate under. These permits are based on county, state, and federal regulations. Requirements to obtain the permit include: tank odor control, emissions limits, and emission control scrubbers (e.g., sodium hydroxide and sodium hypochlorite tanks). Both West Area and Arrowhead WRF have modified their equipment by adding a non-chemical scrubber system. These changes require permit modifications. Cholla WTP's Air Quality Permit specifies that materials such as acids, alkalis, solvents, and other volatile compounds must be processed, stored, used, and transported to minimize the risk of leakage.

Maintenance and Operation

Forms

The 2009 International Fire Code specifies that the entity must fill out a HMMP and submit it to the Glendale Fire Marshal Hazardous Materials Unit if: any structure classified as hazardous occupancy — a SARA Title III extremely hazardous substance — is on site in quantities above the threshold planning quantities, or the Fire Marshall deems it necessary due to unique circumstances. This HMMP must include: material name, hazard classification, chemical state, quantity stored, and conditions of its storage. It must also include the location of emergency isolation, on and off valve positions, intended storage arrangements, and the location/type of emergency equipment. An HMIS and SDS must be submitted with the HMMP (Table 2). These submissions must be completed

annually when the HMMP is renewed, 60 days before the Hazardous Materials Permit expires. HMIS amendments must be submitted within 30 days of changes to the status of the hazard class, storage quantity increases >5%, or the storage of the hazardous materials changes.

OSHA echoes the International Fire Code in requiring facilities to have SDS for each hazardous material used in the workplace, as well as a list of all hazardous materials, such as an HMIS.

International Fire Code Required Forms	
Hazardous Materials Management Plan (HMMP)	Includes site and floor plan showing location of emergency equipment, exits, aboveground and underground storage tanks, and hazard classes of each area
Hazardous Materials Inventory Statement (HMIS)	Provides summary report for each area and includes inventory amounts of solids, liquids, and gases, tank locations, and hazard classification
Safety Data Sheets (SDS)	Contains information on potential health, fire, reactivity, and environmental hazards of a chemical product and how to work safely with it

Table 2 *International Fire Code Required Forms*

The Emergency Planning and Community Right-to-Know Act (EPCRA) requires submission of several forms and reports including the HMIS, SDSs, an annual Tier II report and an annual Toxic Release Inventory (TRI) report. The Tier II report discloses annual storage amounts for listed hazardous substances. When tank contents are determined to meet or exceed EPCRA Threshold Planning Quantities (TPQs), Glendale must ensure the appropriate forms are submitted to the State Emergency Response Commission, the Local Emergency Planning Committee, and the Fire Department. City staff disclosed that the required Tier II reports are submitted each year.

Storage and Protections

SDS contain information on flash points, which are used to classify chemicals as flammable or combustible. If necessary, NFPA 30 Section 4.4 provides the procedures for closed-cup flash point tests. For drums <119 gallons and intermediate bulk containers <793 gallons, facilities must ensure that liquids classified as flammable or combustible are only stored in appropriate containers based on classification. Additionally, the standards set for smaller tanks can be applied to larger tanks.

4.3.1 Flammable liquids, as defined in 3.3.33.2 and 4.2.3, shall be classified as Class I liquids and shall be further subclassified in accordance with the following:

Class IA Liquid – Any liquid that has a flash point below 73°F (22°C) and a boiling point below 100°F (37.8°C)

Class IB Liquid – Any liquid that has a flash point below 73°F (22°C) and a boiling point at or above 100°F (37.8°C)

Class IC Liquid – Any liquid that has a flash point at or above 73°F (22°C), but below 100°F (37.8°C)

4.3.2 Combustible liquids, as defined in 3.3.33.1 and 4.2.2, shall be classified in accordance with the following:

Class II Liquid – Any liquid that has a flash point above 100°F (37.8°C) and below 140F (60°C)

Class III Liquid – Any liquid that has a flash point at or above 140°F (60°C)

Class IIIA Liquid – Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C)

Class IIIB Liquid - Any liquid that has a flash point at or above 200°F (93°C)

Figure 4 *Classification for flammable and combustible liquids according to NFPA 30*

The permitting and installation process for fuel ASTs required by the Fire Marshal's Office within the Arizona Department of Forestry and Fire Management (ADFFM) includes requirements for storage, security, and precautions regarding fuel tanks. The requirements include: overfill protection, 5-gallon spill fill protection, fire extinguishers within 75 feet of the tanks, hazard signage, and tanks secured from public access.

Further requirements on hazardous materials and spills can be found in OSHA. Decontamination procedures, personal protective equipment (PPE), emergency response plans, incident command systems, new technology, and spill containment programs are detailed in 29 Code of Federal Regulations (CFR) 1920 Subpart H.

NSF ANSI 61 Section 6 states that associated system components that have contact with drinking water treatment chemicals must follow manufacturer's instructions regarding ASTs, pipes, and valves.

Entry and Cleaning

According to OSHA requirements, confined spaces requiring a permit for entry must have signage informing employees or contractors of the existence, location, and danger of the permitted space. Those authorized to enter tanks also require a written confined space permit program. When entering the tank, temporary covers should be put in place to prevent accidental fall-ins; the internal atmosphere should be tested for air contaminants; ventilation should be provided to remove any hazardous gases from the atmosphere; and the atmosphere should be rechecked periodically while people are inside the tank. **Glendale is responsible for ensuring that workers are not exposed to chemical vapors exceeding enforceable standards.**

OSHA includes regulations specifically for host employers and hired contractors regarding work in confined spaces. The host employer must inform the contractor of permitted work spaces, apprise them of tank contents and associated hazards, coordinate the entry operations with the contractor, and debrief the contractor at the end of entry operations. In the written confined space permit program, the hired contractors are required to provide necessary equipment for the entry work and provide at least one attendant to supervise the operations from the outside.

The confined space entry permit itself is detailed in 29 CFR 1910.146(e). It must include the space to be entered, the purpose of entry, the date and duration of entry, the hazards of the space, and the PPE and communications equipment used. The permit must be posted at the job site until the entry work is done. A sample Confined Space Entry Permit is provided in Appendix A of the Schneider et al., report.

NFPA 326 Chapter 10 requires that the cleaning of ASTs should be done before a change in service, in preparation for work that could result in an ignition incident, known as “hot work,” or for other purposes as necessary. Residual liquids and solids must be removed and placed in appropriate containers depending on chemical characteristics. An inspection should be conducted after the cleaning to ensure it was effective.

Editor's Note
Glendale's contracts are written such that inspection companies retain liability. The City should ensure that these agreements are accurately implemented.

NFPA 326 Chapter 5.2 requires the removal of as much of the AST hazardous contents as is practical, using chemically appropriate piping and fittings. Any vents associated with the tank system should be isolated from the vents of other tanks not being serviced. The air inside the tank should be tested for hazardous vapors regularly throughout the process according to NFPA 326 Chapter 6. In Chapter 8, qualified personnel must certify the tank for allowed level of entry based on the previously mentioned prerequisite tasks and testing.

This standard mostly applies to companies contracted to enter and clean the ASTs. To this end, the City writes contracts with companies such that they hold liability for ensuring the correct regulations and standards are followed to maintain worker safety and suitable tank conditions.

Inspections

According to the Steel Tank Institute's 2018 publication of the Standard for the Inspection of ASTs (2018), the tank owner's inspector should conduct periodic inspections. They must be familiar with ASTs, the spill control system, the content, and the pumping, piping, and valve operations. The inspector should use the STI/SPFA SP001 Monthly and Annual Inspection Checklists, available in Appendix A of the Schneider et al. report.

A certified inspector should conduct Formal External Inspections (FEI) and Formal Internal Inspections (FII). They must be a STI-Certified SP001 AST Tank System Inspector or certified by the API Standard 653 Authorized Inspector Certification with STI SP001 Adjunct Certification (STI Section 4.2, 2018). The FEI [forms/records] should include AST structure, ancillary equipment, shell thickness, and secondary containment condition depending on verticality or horizontality. FII criteria changes depending on verticality and horizontality. Inspections must check for corrosion and cracking, in addition to the requirements for FEI.

ASTs are placed in three categories, described below:

Category 1 - ASTs with spill control and continuous release detection methods (CRDM)
Category 2 - ASTs with spill control and no CRDM
Category 3 - AST without spill control

Table 3 shows the inspection schedules for each AST category. The inspections are as follows:

P: Periodic tank inspection by owner's inspector
E: Formal External Inspection by Certified Inspector
I: Formal Internal Inspection by Certified Inspector
L: Leak test by owner or owner's designee

Inspection Schedules				
AST Type and Capacity in US Gallons (liters)		**Category 1**	**Category 2**	**Category 3**
Shop-Fabricated ASTs	0 - 1,100 (0-4,164 liters)	P	P	P, E & L (10)
	1,101 - 5,000 (4,168-18,927 liters)	P	P, E & L (10)	[P, E & L(5), I(10)] or [P,L(2), E(5)]
	5,001 - 30,000 (18,931-113,562 liters)	P, E(20)	[P, E(10) & I(20)] or [P, E(5), L (10)]	[P, E&L (5), I(10)] or [P, L(1), E(5)]
	30,001 - 75,000 (113,566-283,906 liters)	P, E(20)	P, E&L(5), I(15)	P, E&L(5), I(10)
Portable Containers		P	P	P**
** Owner shall either discontinue use of portable container for storage or have the portable container DoT (Department of Transportation) tested and recertified per the following schedule (refer to Section 9.0): Plastic portable container - every 7 years Steel portable container - every 12 years Stainless Steel portable container - every 17 years				

Table 3 *Inspection Schedules. Numbers contained in parentheses dictate the required number of years between inspections.*

Section 6 of API STD 653 also outlines internal and external inspections (see p.35 of the Schneider et al. report). **Owner/operator visual inspections should be done routinely.** Authorized inspectors should conduct external inspection at least every 5 years (Section 6.3.2); internal inspections at least every 20 years, but the actual frequency depends on the bottom corrosion rate to ensure the thickness does not drop below acceptable limits. The standard states that there are several factors that must be considered in determining inspection frequency, including tank contents, visual inspection results, leak and pollution risk potential, and the jurisdictional requirements. Appendix C of the standard provides sample checklists for external and internal inspections. Appendix D of the standard provides the certification standards for authorized inspectors.

Section 4 of API STD 653 discusses requirements for evaluating tank roofs, walls, and bottoms for corrosion, stress levels, foundation, and filling and emptying rates and frequencies. Deteriorating tanks are at risk for leaking chemicals, so according to Section 4.1.1, "when the results of a tank inspection show that a change has occurred from the original physical condition of the tank, an evaluation shall be made to determine its suitability for continued use." Evaluations should include calculations for actual thickness (Section 4.3.2) and minimum thickness of the walls (Section 4.3.3.1 [welded shell] and Section 4.3.4.1 [riveted shell]) and bottom (Section 4.4.7.1), and should reference the tables, such as Table 4-1 provided in the standard for determining allowable shell stresses (see Appendix A, of Schneider et al., p.35).

These two sources provide slightly different standards for the inspection frequency and metric, as summarized in Table 3. STI/SPFA ST001 is more thorough in laying out the schedule and criteria for tank inspections, and API STD 653 clarifies the need for corrosion evaluation. See Recommendations section on page 46 of this report for suggested elements of an SOP.

Inspection Criteria for STI/SPFA ST001 vs API STD 653		
Table 3	**STI/SPFA ST001**	**API STD 653**
Periodic Inspections	***Frequency*** Monthly and annually ***Inspector*** Owner's inspector ***Criteria*** Monthly and annual checklists (see Appendix, pages 31-34)	***Frequency*** On a routine basis ***Inspector*** Owner/operator or authorized facility personnel ***Criteria*** Check tank surface for corrosion, distortion, and evidence of leaks or settlement Note condition of paint coating, foundation, and appurtenances for follow-up by authorized inspectors
External Inspections	***Frequency*** Every 5, 10, or 20 years, depending on tank capacity ***Inspector*** STI Certified Inspector or API Authorized Inspector with STI Adjunct Certification ***Criteria*** Check AST structure, shell thickness, secondary containment condition	***Frequency*** Every 5 years minimum ***Inspector*** API Authorized Inspector (refer to API STD 653, 2001, Appendix D) ***Criteria*** Check condition of walls and roof, shell thickness, tank grounding systems such as shunts or mechanical connections Refer to sample checklist for in-service tanks (API STD 653, 2001, C-3 to C-8)
Internal Inspections	***Frequency*** Every 10, 15, or 20 years, depending on tank capacity ***Inspector*** STI Certified Inspector or API Authorized Inspector with STI Adjunct Certification ***Criteria*** Same as external inspections, and corrosion and cracking	***Frequency*** Every 20 years minimum, but more often based on corrosion rate ***Inspector*** API Authorized Inspector (refer to API STD 653, 2001, Appendix D) ***Criteria*** Ensure bottom is not seriously corroded or leaking and assess thickness of bottom and walls Identify any tank bottom settlement Refer to sample checklist for out-of-service tanks (API STD 653, 2001, C-9 to C-18)

Table 4 *Inspection Criteria for STI/SPFA ST001 vs API STD 653*

Recommendations for Regulations and Standards

1. Facilities should ensure compliance with permit and renewal conditions and submit appropriate and timely revisions as needed (Schneider et al., p.14).
2. Facilities meeting the applicability standards of the International Fire Code should submit current HMMP, HMIS, and all SDSs to the City's Fire Marshal Hazardous Materials Unit, and ensure permits are renewed on time (Schneider et al., p.14).
3. Facilities using hazardous materials must also keep appropriate SDSs and an HMIS on site, according to OSHA requirements (Schneider et al., p.15).
4. Tanks containing flammable/combustible liquids, and tanks containing potentially toxic and corrosive materials >1,320 gallons should have overfill protections, as specified by NFPA 30, and should be operated and maintained according to manufacturer's instructions (Schneider et al., p.16-17).
5. Facilities should follow OSHA HazWOpER or Hazard Communication requirements to prevent and contain spills, as detailed in 29 CFR 1920 Subpart H (Schneider et al., p.17).
6. Glendale facility supervisors should be familiar with proper protocol for tank entry and cleaning and should ensure outside contractors are following OSHA and NFPA 326 requirements (Schneider et al., p.18-19).
7. Facilities should ensure the ASTs are inspected regularly following the STI or API, or a combination, inspection schedule. These inspections should follow the criteria checklists to ensure proper tank cleanliness, usability, and safety. They should include API STD 653's recommendations for thickness calculations and recording corrosion extent during scheduled inspections (Schneider et al., p.23-24).

To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCGlendaleStorageTanks

BENCHMARKING CASE STUDIES

Entity	Purpose for Inclusion in this Report
Cities and Tribes	These entities offer models/singular practices that may translate in the creation of Glendale's AST program
Military	The US military practices more stringent rules than federal AST regulations
Commercial Sector	Many of the researched companies store and use diesel fuel and hazardous materials

Table 5 *Entity Types Evaluated*

Topic Overview

This section of the report is based on research conducted by students in the Ira A. Fulton Schools of Engineering at the Polytechnic Campus. Students researched best practices of various organizations to provide the City with a baseline model for regulatory compliance and O&M planning. They divided themselves into three sub-groups with each sub-group focusing on a distinct sector: the commercial sector, cities and tribes, or the military.

Findings and Analysis

Cities and Tribal Governments

Cities and tribes' programs were examined to demonstrate practices of other municipalities in regards to their AST management. Tribes serve as interesting case studies because they have created their own unique set of AST regulations.

State of Pennsylvania AST Management Program

In Pennsylvania, the Department of Environmental Protection (PA DEP) has been designated as the regulating agency for ASTs. The PA DEP created detailed O&M standards (PA DEP, 2019). These standards require the AST facility owner/operator to have onsite written operations and maintenance plans with applicable safety and operational standards.

Listed below are highlights of Pennsylvania's O&M Program. For more information on O&M of ASTs, refer to The Pennsylvania Code Title 25 Chapter 245 (Kemp et al., p.8).

- Routine maintenance inspection consists of a visual AST inspection every 72 hours. Inspection is done to reduce potential environmental hazards.
    - Check evidence of a release such as a spill, overflow or leakage of the regulated substance
    - Check containment area for accumulation of water and a confirmation that containment drain valves are in the closed position when not in use.
- AST facility owner/operator must ensure monthly maintenance inspection of the facility and equipment
    - The monthly inspection includes checks for deterioration and maintenance deficiencies, such as visible cracks, areas of wear, and deterioration of the foundation and supports of the surface tank system exterior.
    - Equipment shall be visually checked for operational malfunctions.
    - Ensure containment and transfer areas are free of cracks, defects, and fire hazards.
    - Check overfill prevention equipment and monitor the leak detection system.
- Only PA DEP certified inspectors can conduct in-service and out-of-service inspections, installations and modification inspections (PA DEP, 2019).
    - In-service inspections must be conducted every 10 years or less when there's corrosion, deterioration, or other conditions.

Editor's Note
The term in-service inspection refers to a periodic inspection about every ten years to verify that the tank continues to exhibit sufficient structural integrity to operate for another ten years.

Within their AST management program, Pennsylvania has employed additional standards and practices that go beyond the existing federal regulations. An example is mandatory routine visual inspections of ASTs every 72 hours. This standard is far more rigorous than other facilities, which inspect on a monthly basis. In addition, only Department certified inspectors can conduct in-service and out-service inspections, installations, and modification inspections.

White Mountain Apache Tribe

The Tribe has a small number of ASTs. Most of these tanks are water tanks >1,000 gallons with National Pollutant Discharge Elimination System (NPDES) permits in place to manage/mitigate discharge into water of the US. The remaining tanks follow National Fire Protection Association (NFPA) guidelines in case of fire or emergency.

Students found no significant improvement over the federal AST requirements (Kemp et al., p.10).

Navajo Nation Underground and AST Act

In 2010, the Navajo Nation Council enacted a law regulating the release of petroleum products and other hazardous liquids from underground and ASTs. The law requires corrective action in the event of releases of regulated substances and financial assurances consistent with Title VI of the Hazardous and Solid Waste Amendments of 1984, P.L. 98-618, 42 U.S.C. §§ (Navajo Nation EPA, 2010. Referenced from Kemp et al., p.11).

- All storage tanks in the Navajo Nation, whether underground or aboveground, must be designed to prevent releases associated with corrosion or structural failure for the entire operational life of the tank.
    - The tanks must be cathodically protected (CP) against corrosion or constructed of noncorrosive material. **The CP technique protects the structure from corrosion by adding a sacrificial metal lining.**
    - Material used to construct or line the storage tanks must be chemically compatible with the substance to be stored.
    - Tanks must be equipped with spill and overfill prevention devices, installed in accordance with manufacturer specifications and appropriate technical industry standards.
    - An owner or operator must notify the Navajo Nation Storage Tank Program within 30 days, of any upgrade, storage tank replacement, or change in the use of a storage tank.

- The Navajo Nation has adopted the EPA requirement, 40 C.F.R. § 280.43(g), for secondary containment of regulated substances stored in ASTs.
    - Compliance with Navajo Nation regulations does not relieve a person of the obligation to comply with other applicable laws and regulations, including the Navajo Nation Oil Pollution Prevention Regulations promulgated under the Navajo Nation Clean Water Act.
    - Tanks and facilities exempt under the Navajo Nation Underground and AST Act may be subject to the provisions of the Navajo Nation Clean Water Act.
- Navajo Nation requires that any upgrade, tank replacement, or change in tank use be reported to the Navajo Nation Tank Program within 30 days. This significant requirement will help to improve and maintain their AST inventory and program.

Military Installations

Across all branches of the US military, regulation of the use and storage of diesel fuel and other potentially dangerous chemicals is prevalent. Along with the federal requirements for AST management, the military abides by their own stricter rules, which may be useful to Glendale in their mission to lead cities in AST management.

Air Force

In the Air Force, ASTs contain a variety of gases and fluids, including lubricating oils, and various fuels as well as hazardous materials and wastes. Along with federal AST requirements, the Air Force and Department of Defense (DoD) set other requirements found in a collection of documents including the Air Force Instructions (AFIs), Air Force Manuals (AFMANs), Military Standards (MIL-STDs), Engineering Technical Letters (ETLs), Policy Letters issued by Headquarters agencies, as well as DoD standards and handbooks.

- These requirements include AFI 32-1054 “Corrosion Control," AFI 32-7044 “Storage Tank Compliance," and HQ USAF/CEV Air Force Guidance for Toxic Release Inventory (TRI) Reporting.
- Construction standards to ensure worker safety are found in Title 29 CFR 1910.106 for tanks containing flammable and combustible liquids. This standard explains material and fabrication requirements, along with opening, venting, and emergency relief requirements for ASTs.

The Air Force's manual, the AFMAN, describes applicable federal regulations and additional Air Force standards.

- The AFMAN lists Air Force specific guidelines that are easily understood. This is significant as a best practice as it is a comprehensive document which serves in helping to maintain their ASTs.

Army

At Fort Bragg, an important part of inspecting ASTs is ensuring there is living grass growing around the bottom of the tanks. The presence of damaged and dying grass is an indicator of possible leaks from a nearby tank. However, the inspection process of these tanks goes much further than this visual check. There are two environmental protection regulations that Army bases follow. Fort Bragg (along with other bases such as Fort Benning, Fort Huachuca, and Fort Carson) adheres to specific rules and regulations derived from the Army Environmental Regulations AR 200-1 "Environmental Protection and Enhancement" and AR 200-3 "Natural Resources, Land, Forest, and Wildlife Management."

For Army bases, an inspection of aboveground oil/product storage tanks must be completed weekly and retained in a binder for three years (Kemp et al., p.12). Responses from an inspection form from Fort Bragg are included below. This inspection form can be found under FB Form 3003-1. Refer to Appendix B of the Kemp et al. Report.

Fort Huachuca adheres to EPA regulations, the Arizona State Fire Marshal, AR 200-1, and the Clean Water Act for AST management. Fort Huachuca uses secondary containment under all ASTs unless the ASTs are double walled and have a high liquid level alarm and a flow restrictor or automatic shutoff device.

1. Fort Huachuca uses inspection forms from the Steel Tank Institute.
2. Fort Huachuca does not use a Standard Operating Procedure (SOP) or Technical Operating Procedure for ASTs.
3. Fort Huachuca employs an O&M contractor to do O&M on an as needed basis.
    - When a tank inspector notices that any AST is in need of repair or maintenance, the tank inspector notifies the O&M contractor as well as the unit that is using the tank. The unit using the tank is notified because the tank could be a risk to the unit's operation and mission.

Fort Carson follows the State of Colorado rule 7 C.C.R. 1101-14, also known as "Storage Tank Regulations" from the Division of Oil and Public Safety. This regulation covers a wide range of information for ASTs including but not limited to operation, closures, upgrades, and repairs as well as providing information on reporting releases, and enforcement of violations. The storage tank regulations from the Division of Oil and Public Safety pulls some information about AST design from C.R.S § 8-20-231 which is a Colorado statute on fuel products. This statute takes its information from the NFPA.

- An example of the information provided in 7 C.C.R. 1101-14: "Every AST shall have some form of construction or device that will relieve excessive internal pressure caused by exposure to fires."
    - This requirement shall also apply to each compartment of a compartmented tank, the interstitial space of secondary containment-type tanks, and the enclosed space of closed-top dike tanks, except where the tank was constructed prior to the publication of the 1996 edition of NFPA 30 0987 "Flammable and Combustible Liquids Code."
- Fort Carson bases their AST requirements on 7 C.C.R.1101-14, 40 CFR 279.22 Used Oil Storage. The regulatory authority is the Colorado Department of Labor and Employment, Division of Oil and Public Safety (OPS).
    - Fort Carson continually updates their AST database to maintain records with the state of Colorado and maintains a Spill Prevention Control and Countermeasures (SPCC) Plan to stay in compliance.
    - This plan is continually reviewed and updated for improvement and for conformance with new regulations.
    - In accordance with the plan, spill and release incidents from ASTs are reported to the regulatory agencies and the National Response Center.
    - Performance Plans are also reviewed regularly to anticipate changes in regulatory requirements by State and Federal authorities. All the plans and SOPs at Fort Carson are reviewed and updated annually or as needed.

The Army has created the Army Environmental Regulations to serve as a guiding document for environmental protection from damage, including that from ASTs. **A best practice drawn from these regulations is the inclusion of a 'battery' as an inspection point, which is left off of most SOPs.** Some horns and/or lights on ASTs are battery powered and the status of the battery is vital in ensuring proper operation.

Navy & Marines

The US Navy and the US Marine Corps often work together to develop training programs and workshops. Both parties follow an Environmental Compliance and Protection Program implemented by the Commandant of the US Marine Corps (Marine Corps Order 5090) 2 (MCO 5090.2, 2018). There are only a few statements made specifically about ASTs in this order. According to Section 031104, all safety data sheets must be maintained on site, and the appropriate regulatory agency is to be notified of construction, reconstruction or modification of petroleum ASTs. These records must be maintained for a minimum of 3 years after their release. ASTs must also stay in compliance with facility drainage, bulk storage container, facility transfer operations, pumping, and facility process requirements (Kemp et al., p.15). Additionally, the Marine Corps and Navy inspect their ASTs using the Steel Tank Institute (STI) checklist.

Marine Corps Base, Quantico (MCBQ) Environmental Standard Operating Procedure (ESOP) has procedures for storing all unused petroleum products. There are four inspection checklists provided in the document (daily, weekly, monthly, and annually) that must be filled out by tank inspectors or environmental program managers. (Checklists are found in Appendices B-D in the Kemp et al. report). The frequencies of these inspections vary based on the regulations associated with different types of ASTs.

- All documents, including inspection reports and repair invoices for each tank must be kept for at least five years.
- Corrective actions must be taken for any deficiencies identified during an inspection.
- Primary and alternative tank inspectors must meet certain training requirements to ensure safety due to risks of storing fuel.

The variation in inspection frequency at MCBQ helps maintain a relevant database of baselines for records. The requirement for retaining all inspection reports and repair invoices for at least five years further strengthens their best practice.

Coast Guard

The US Coast Guard has stringent specifications for their existing tank systems, as they require corrosion protection for steel tanks/piping and use devices that prevent spills and overflows. They conduct monthly inspections using monitoring methods such as automatic tank gauging, monitoring for vapors in the soil, interstitial monitoring, monitoring for

liquids in the groundwater, and other approved methods. Depending on the type of piping used, the Coast Guard has several different methods for line leak detection.

- Pressurized piping must have devices that automatically shut off or restrict flow or have an alarm to indicate a leak.
- Monthly monitoring or an annual tightness test must be performed to test for leaks. Suction piping must be monitored monthly or have a tightness test of the piping performed every three years.
- ASTs must have corrosion protection.

There are multiple options for the required corrosion protection: coated and cathodically protected steel, fiberglass, steel tank clad with fiberglass, cathodic protection system, interior lining and interior lining and cathodic protection. The associated piping must also have corrosion protection.

- The options for piping are coated and cathodically protected steel, fiberglass and cathodically protected steel.
- They also require catchment basins and automatic shutoff devices or overfill alarms or ball float valves for all ASTs as a spill/overflow prevention method.

The ASTs are required to be periodically tested for integrity in accordance with 40 CFR 112.7 (e)(2)(vi) and must be routinely observed by facility workers to check for signs of deterioration or leaks that could cause a spill or accumulation of oil in the containment areas. Tank system testing and leak effects monitoring are used to detect leaks. The Coast Guard policy on the closure of tanks is based on federal, state, and local regulations. The Coast Guard is required to prepare a SPCC Plan in accordance with 40 CFR 112.7. In Appendix C of the Kemp et al. report, there is a spill prevention control and countermeasures plan outline, a sample inventory control records for the US Coast Guard, and a sample SPCC Inspection Format.

The Coast Guard has established inspection criteria more stringent than federal regulations involving leak monitoring. These criteria include monthly monitoring for vapors in the soil, liquids in the groundwater, and interstitial monitoring. The use of double-wall tanks is another best practice, as these tanks are safer than single-wall tanks and offer more protection along with an encasement to capture leaks. The Coast Guard also tests their suction piping every three years for tightness, with monthly monitoring for leaks. Such practices minimize hazards to the environment and to the workers.

International Military Bases

All ASTs on international military bases must comply with EPA regulations, AR 200-1, and AR 200-3. There are no "best practices" for these international bases other than to follow current environmental regulations.

Students attempted to establish contact with seven regional commands within the US Forces - Europe (USFEUR), but only one responded with a (partial) explanation of their AST practices. Students focused on European bases because of the cultural similarities between the US and western Europe with significant US military presence. All ASTs on international military bases must comply with EPA regulations as well as branch- and theatre-specific regulations; these ASTs are also subject to host national oversight in accordance with their respective Status of Forces Agreements (SOFAs). For example, U.S. Forces, Europe falls under the purview of the European Union, and subsequently EU member-states, whose environmental regulations are generally viewed as being more stringent than those in place in the US.

Students found no significant improvement over the federal AST requirements for ASTs on international bases, besides additional subjection to EU regulations.

Commercial Sector

The commercial sector relies heavily upon current laws and regulations for compliance with their ASTs. Companies do not post their internal AST SOPs on the internet. The students contacted individuals within several companies to ask them to share their SOPs.

Honeywell

Honeywell has a formal document known as the 'Site Level Procedure' that provides guidance in managing ASTs and their stored chemicals (full document is available in Appendix M of the Kemp et al. report). The company has established best practices for their ASTs that are more stringent than federal standards, as they include regulations for the storage, as well as containment areas, of the ASTs. **Label visibility, aisle space, incompatible liquids, and outside storage are included and defined in Honeywell's Site Level Procedure document.** Provisions are included for rainfall on outdoor and exposed storage areas as well as for the height of the secondary containment wall. These are factors that are vital yet scarcely discussed in other documents. Another best practice by Honeywell is routine annual training for their employees on storage tanks and their surrounding areas. Students were able to obtain Honeywell's sample Chemical Container Management Inspections checklist, found in Appendix L of the Kemp et al. report.

Boeing

Boeing treats metal-containing wastewater in an onsite wastewater treatment plant. The plant has three inlet pits, two 2,000 gallon holding tanks, a third 2,000 gallon batch reaction tank, a filter press, a final surge tank, and a 10-micron polishing filter for discharge through an outfall to the sewers. Boeing Rotorcraft Mesa discharges three to four 1,500 gallon treated batches per week. The batch reaction tank involves chromium reduction, metals precipitation, iron coprecipitation, polymer flocculation, and gravity clarification. The batch reaction tank contents are pre-tested for pH and hexavalent chromium and final tested after each batch for chromium and copper. The metals bearing wastewaters are segregated by treatability. Hence, regulation through the Clean Water Act (CWA) and National Pollutant Discharge Elimination System (NPDES) permits (US EPA, 2010).

Students found no significant improvement over federal AST requirements at Boeing.

NXP Semiconductors & PURECHEM

NXP Semiconductors follows the CWA, The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and The Resource Conservation and Recovery Act (RCRA) as their basis for compliance with AST procedures. PURECHEM, which is a part of A-Gas, also relies on FIFRA, CWA, and RCRA to be in compliance with their ASTs and they do not have an SOP listed.

Students found no significant improvement over federal AST requirements at NXP Semiconductors and PURECHEM.

Arizona Public Service

Arizona Public Service (APS) has no official SOP for the management of their ASTs, but follows the standards and regulations that relate to their tanks based on the type, size, and what they contain (Kemp et al., p.22). Location is also key, along with whether the tank is shop built or field erected. For tanks that hold over one million gallons, the API industry standard is followed, and those that hold thousands of gallons use the STI industry standard.

- If the AST holds oil and is near a Water of the US, then APS follows their SPCC program. Depending on tank size and construction, they conduct integrity testing on a periodic basis and regular inspections monthly.
- APS tanks have overfill-protection devices, electronic monitoring systems, are UL listed, and in compliance with fire codes.
- Vendors and APS employees must follow an oil-transfer procedure when on APS property.
- APS mostly uses double-walled tanks, another management best practice, as these tanks take less space, are safer, and offer more protection due to their built-in encasement to capture leaks.

ASU Environmental Health and Safety (ASU EH&S)

ASU EH&S compiled a Facilities Development and Management (FDM) Project Guidelines document, detailing best practices and management for different installations of devices including tanks within ASU's buildings and facilities.

The students' ASU contact mentioned concerns about piping and proximity to city sewer and stormwater drains (Kemp et al., p.23). There are some double-walled tanks in use, with a few requiring overfill protection. The FDM Project Guidelines requires that tanks storing hydraulic fluid must be able to hold all the fluid along with an additional 25% of the tank capacity.

ASU EH&S has a few double-wall tanks, a best management practice, as they are more secure and offer better containment of leaks.

Ping

Ping does not have a formal SOP. However, this company has incorporated elements from the STI SP001 Standard for ASTs to manage and maintain their ASTs. Ping's monthly and annual checklists were derived from the STI SP001 Monthly Inspection Checklist and STI SP001 Portable Container Monthly Inspection Checklist, which can be found in Appendices S and T in the Kemp et al. report.

Ping employs the best practice of increasing their inspection frequency when activities are planned near the site. In addition to routine monthly and annual inspections, these proactive inspections can be conducted daily or even weekly as a safety precaution. Another Ping best practice is to include generator and transformer diesel tanks on the annual inspection checklist. Other organizations reviewed for this report found that the backup generator and transformer tanks are not always identified, resulting in missed inspections. Because diesel fuel degrades in the Phoenix metro area after six months, inspections should occur monthly or quarterly. Lastly, internal and external preventative maintenance measures are included on the annual checklist.

Students found several best practices within the Ping procedures, with prevention a key to success for AST management.

Federal Aviation Administration (FAA)

The FAA uses more stringent internal standards because they have ASTs in almost every state, making compliance with local codes arduous so their policies set a higher standard (Kemp et al., p.23). The FAA requires ASTs to adhere to the SPCC rule in 40 CFR 112 and requires monitoring, testing, and validation of structural integrity requirements (FAA, 2018).

Students found no significant improvement over the federal AST requirements for the FAA.

Unified Program (UP)
The California Health and Safety code authorizes administration of the UP. The UP was implemented at the local government level by agencies certified by the Cal/EPA (LAX 2014). The purpose of the UP is to consolidate, coordinate and make permits, inspections, and consistent administrative requirements. The UP carries out enforcement activities and a few of the environmental and emergency response programs. Since 1997 the City of Los Angeles Fire Department (LAFD) has been certified and designated as the City's Unified Program Agency (CUPA).

The LAFD has an agreement with the County of Los Angeles to perform the hazardous waste components of the Unified Program (Kemp et al., p.25). The CUPAs have the responsibility and authority to implement the Aboveground Petroleum Storage Act (APSA). APSA defines a "storage tank" as 'any aboveground tank or container used for the storage of petroleum except as specified'. In accordance with the federal SPCC requirements at 40 CFR 112, the APSA requires that the owner or operator of the tank facility that has an aggregate storage capacity greater than or equal to 1,320 gallons of petroleum must implement an SPCC. As a best practice, Cal/EPA has established a governing agency, CUPA, which regulates the AST program.

Editor's Note
The LA Fire Department is the inspection and enforcement agency to determine compliance with APSA. It cannot be determined whether or not the APSA requirements are more stringent than the EPA SPCC requirements.

The presence of an agency on a county level increases regulation and proper oversight, further ensuring compliance, benefiting the entire county of Los Angeles.

Phoenix Sky Harbor International Airport (PHX)
At PHX, fuel is stored in both ASTs and USTs. The airport has officially addressed the existence of their ASTs in relation to stormwater pollution prevention (Phoenix 2016). Totes of 250 gallons or less are also used onsite to retain paint, chemical toilet blue water, liquid soaps, as well as glycol-based de-icing fluids. Spill kits are required to be kept close to any fuel transfer and for the ASTs.

Students found no significant improvement over the federal requirements for ASTs for PHX.

Transportation Carriers & Haulers

FedEx, USPS, UPS
The top mail/delivery carriers were contacted via various mediums such as email, phone calls, and live queries. No viable information was collected. No significant improvement over the federal AST requirements was found from these delivery carriers.

U-Haul
The U-Haul Headquarters was contacted, however responding employees were unable to assist in finding any information on their company and the use of any ASTs. The company has no SOP for ASTs that could be found by the employees who were contacted.

Students found no significant improvement over the federal AST requirements for U-Haul.

SWIFT Transportation
SWIFT Transportation is an American truckload carrier that specializes in intermodal transportation services and logistics. The company was contacted and relayed contact information to their maintenance section. The contact was not knowledgeable about any ASTs within their facilities.

No significant improvement over federal AST requirements were found for SWIFT.

Located below and on the following page are matrices summarizing current practices in managing ASTs based on the researched cities, military installations, and the commercial sector.

Benchmarking Summary of AST Management in Municipal and Tribal Entities						
Municipality/ Tribe	**SOP**	**Regulating agencies/ standards**	**Tanks type/ chemicals**	**Inspection criteria**	**Frequency of inspection**	**Record-keeping**
State of Pennsylvania	√	PA Dept. of Environmental Protection, SPCC	API, STI, Petroleum Equipment Institute RP 200, NACE Intl.	Checklists	Every 72 hrs. (visual)	3 yrs. min.
NASAP	√	National Association of reps from state AST reg. agencies	National database for all ASTs (varies by state)	Checklists	Varies by state	Varies by state
Navajo Nation (T)	X	Navajo Nation Council, Navajo Nation Storage Tank Program, NNCWA, NN Pollution Prevention Regs., SPCC	/	Checklists	Every 30 days	3 yrs. min.
Apache (T)	X	NPDES, NFPA, SPCC	Water, various chemicals	Checklists	Every 30 days	3 yrs. min.
Key: (T) - Tribal; (I) - Industry; (t) -Transportation; Data not found or none - /; Present - √; Not Present - X						

Table 6 *Benchmarking Summary of AST Management in Tribal Entities (Kemp et al., p.28)*

Benchmarking Summary of AST Management in Military Entities						
Military Body	**SOP**	**Regulating agencies/ standards**	**Tanks type/ chemicals**	**Inspection criteria**	**Frequency of inspection**	**Record-keeping**
Airforce	√	Airforce, OSHA, DoD, SPCC, AFI, AFMANs, MIL-STDs, ETLs	Flammable/ Combustible liquids, motor & aviation fuels, oils	Checklists	Every 30 days	3 yrs. min.
Army	√	Army, NFPA, SPCC, Army Environmental regs.,	/	Checklists	Every 30 days	3 yrs. min.
Navy & Marines	√	Marine Corps Order, STI, MCBQ ESOP, SPCC	/	Checklists	Daily/weekly/ monthly/ annually	5 yrs. min.
Coast Guard	√	EPA, AR 200-1, AR 200-3, SPCC	Fiberglass, steel	Checklists	Every 30 days	3 yrs. min.
International Bases	√	SPCC, AR 200-1, AR 200-3, EU	/	Checklists	Every 30 days	3 yrs. min.
Key: (T) - Tribal; (I) - Industry; (t) -Transportation; Data not found or none - /; Present - √; Not Present - X						

Table 7 *Benchmarking Summary of AST Management in Military Entities (Kemp et al., p.28)*

Benchmarking Summary of AST Management in Commercial Entities						
Company	**SOP**	**Regulating agencies/ standards**	**Tanks type/ chemicals**	**Inspection criteria**	**Frequency of inspection**	**Record-keeping**
Honeywell (i)	√	SPCC, STI, APS, HSEMS	Oil, chemicals	Checklists	Every 30 days	3 yrs. min.
Boeing (i)	X	CWA, NPDES, SPCC	Batch metal treatment chemicals	Checklists	Every 30 days	3 yrs. min.
NXP & PURECHEM (i)	X	FIFRA, CWA, RCRA, SPCC	/	Checklists	/	3 yrs. min.
APS (i)	X	SPCC, API, STI	Oil, chemicals	Checklists	Every 30 days	3 yrs. min.
ASU EH&S (i)	X	EH&S FDM Guidelines, SPCC	Hydraulic fluid	Checklists	Every 30 days	3 yrs. min.
Ping (i)	X	SPCC. STI	Diesel, chemicals	Checklists	Every 30 days & annually	3 yrs. min.
FAA (t)	X	SPCC	Fuel	Checklists	/	3 yrs. min.
LAX (t)	X	Cal/EPA, LAFD, NFPA, FAR, SPCC, UP, CUPA	Fuel	Checklists	Every 30 days	3 yrs. min.
PHX (t)	X	SPCC	Fuel	Checklists	Every 30 days	3 yrs. min.
FedEx, USPS, UPS, U-Haul (t)	X	SPCC	/	Checklists	/	3 yrs. min.
Key: (T) - Tribal; (i) - Industry; (t) -Transportation; Data not found or none - /; Present - √; Not Present - X						

Table 8 *Benchmarking Summary of AST Management in Commercial Entities (Kemp et al., p.28)*

Recommendations from Benchmarking

Best Practices

- Conduct routine visual inspections every 72 hours (Kemp et al., p.29).
- Practice regular inspections at least once a month or bi-weekly to ensure consistent functioning and optimal structural integrity of the tank (Kemp et al., p.30).
- Include a visual inspection of grass surrounding storage tanks as an indicator for leak detection (Kemp et al., p.29).
- Require mandatory reporting of any upgrade, change in use, or replacement of tank within 30 days (Kemp et al., p.29).
- Compile Standard Operating Procedure (SOP) best practices and industry standards into a comprehensive guide (e.g. Air Force Manual (AFMAN), Army Regulations, ESOP) (Kemp et al., p.29).
- Update Above Ground Storage Tank (AST) and SOP plans annually (Kemp et al., p.29).
- Include battery inspection criteria for battery-powered devices (e.g. horn, automatic lights) on the checklist (Kemp et al., p.29).
- Create checklists for daily, weekly, monthly and annual timeframes (Kemp et al., p.29).
- Establish record retention procedures that hold inspection information for a minimum of 3-5 years (Kemp et al., p.29).
- Conduct routine annual training for employees (Kemp et al., p.29).
- **Monitor pollution by vapors in soil and groundwater** (Kemp et al., p.29).
- Practice interstitial monitoring of double-wall tanks (Kemp et al., p.29).
- Use double-wall tanks whenever possible (Kemp et al., p.29).
- Create specific regulations for storage and containment areas including provisions for outdoor storage and secondary containment wall height (Kemp et al., p.29).
- Customize inspection checklists to the specific facility where each tank is located (Kemp et al., p.29).

Glendale-Specific Recommendations:

- In the Phoenix metropolitan area, diesel fuel degrades after about six months; therefore inspections should occur monthly or quarterly (Kemp et al., p.30).

- Implement a mandatory SOP for all facilities that have ASTs to maintain a healthy management system (Kemp et al., p.31).
- Delegate recordkeeping and compliance to a responsible party to maintain compliance with regulations and adherence to best industry practices. **Proper management of ASTs will mitigate risk to public health and the environment** (Kemp et al., p.31).
- In addition to structural integrity inspections, special attention should also be given to the premises guarding the tank, spill protocols and contained substances (Kemp et al., p.30).
- For all tanks within the City of Glendale, abide by the Fire Department Inspection Code 450, titled 'Storage and Use of Flammable Liquids.' This code required a permit for the storage of flammable and combustible liquids (Glendale Fire Department, 9) (Kemp et al., p.30).
    - The liquids must be contained within approved containers that are properly labeled and include the appropriate hazard signs (Kemp et al., p.30).
    - Tanks should not be stored in buildings that are undergoing construction (Kemp et al., p.30).
- In accordance with the EPA, the Spill Prevention, Control, and Countermeasure (SPCC) Program must be implemented as a minimum base standard for regulated AST inspections and program development (Kemp et al., p.30).
    - As a supplement, the City of Glendale should consider incorporating the applicable and relevant requirements of the SPCC into their SOP for ASTs that are below the SPCC regulatory threshold (Kemp et al., p.30).
    - The SP001 Standard for the Inspection of ASTs by the Steel Tank Institute (STI SP001) and the American Petroleum Institute (API) Standard 653 are notable industry standards that should be considered as a part of the City of Glendale AST SOP. More specific information is detailed in the associated reports (Kemp et al., p.30).
- Industry standards advise mandatory recordkeeping for at least three years for all owners of ASTs. However, it is preferable to maintain records for five years, in order to provide a better baseline of documentation throughout the lifetime of the tank (Kemp et al., p.30).
- Delegate compliance with the SOP to an organizational unit in charge of regulating the tank (Kemp et al., p.30).

Editor's Note
Although not required, the SPCC standards and guidance should be adapted as reasonable for use as the City manages tanks that are not regulated by SPCC. It is a best practice.

Consider following the suggested SOP, Inspection Checklist and Inspection Log that were developed by the students (Kemp et al., p.30). Refer to Appendix Q in the digital folder at **links.asu.edu/PCGlendaleStorageTanks**.

To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCGlendaleStorageTanks

FUEL TANK PROGRAM

Topic Overview

Glendale must ensure that all critical functions of the city will continue in the event of a power outage. Therefore, it is of utmost importance that backup generators are reliable and adequately fueled. Students in ERM 401/501 and EGR 427 Hazardous Waste Management have identified applicable requirements for aboveground storage tanks (ASTs) designated to the housing of fuel for backup generators. This section of the report identifies industry recommended practices and standards for these ASTs. Another goal for this section was to find new ways to extend the longevity of this fuel given that diesel fuel in backup generator tanks may not be consumed for years in addition to the implications of extreme heat in Arizona. Students explored fuel test methods and identified alternatives for fuel storage that may help to increase this longevity.

Research Findings and Analysis

Generator Tank Design, Construction and Inspection

The SP001 Standards for the Inspection of ASTs and American Petroleum Institute (API) (2001) Standard 653 “Tank Inspection, Repair, Alteration, and Reconstruction” ("SPCC Bulk," 2013) are commonly used inspection standards for aboveground bulk storage. The SPCC rule mandates individual testing of each container, except for oil-filled equipment, as it is not a bulk storage container. Additionally, visual inspection for signs of corrosion, deterioration, and spills (accumulated oil) is mandated at intervals determined by the tank manufacturer. SPCC Plans require detailing the frequency and types of testing and inspection of each individual container, outlined by a Professional Engineer (PE).

EPA recommends retention of "formal test records" for the life of the container ("SPCC Bulk," 2013). The SP001 standard can apply for metal tanks and plastic drums, 55 gallons or greater, for tanks used to store materials having a specific gravity <1 (“SPCC Bulk," 2013). The students’ review of the materials contained in most of the City of Glendale tanks showed that the majority of materials have a specific gravity <1 (“SPCC Bulk," 2013). However, only tanks <1,320 gallons were included in the scope of this research.

Summary of SPCC Inspection-, Evaluation-, and Integrity-testing Program Provisions and Associated Recordkeeping Requirements			
Facility Component	Section(s)	Action	Method, Circumstance, and Required Action
(Text in italics indicates the frequency or circumstances for performing the activity, as specified in the SPCC rule.)			
General Requirements Applicable to All Facilities			
Bulk storage containers with no secondary containment and for which an impracticability determination has been made	112.7(d)	**Test**	Integrity testing. ***Periodically***. Integrity testing is required for all bulk storage containers. In cases where no secondary containment is present because it is impacticable, good engineering practice may suggest more frequent testing than would otherwise be scheduled. Note that this includes bulk storage containers at oil production, driling, and workover facilities that are not typically subject to integrity testing requirements
Valves and piping associated with bulk storage containers with no secondary containment and for which an impracticability determination has been made	112.7(d)	**Test**	Integrity and leak testing of valves and piping associated with containers that have no secondary containment as described in 112.7(c). ***Periodically***.
Recordkeeping requirement	112.7(e)	**Record**	Keep written procedures and a signed record of inspections and tests for a period of three years. Records kept under usual and customary business practices will suffice. ***For all actions.***
Lowermost **drain** and all **outlets** of tank car or tank truck at loading/ unloading racks	112.7(h)(3)	**Inspect**	Visually inspect. ***Prior to filling and departure of tank car or tank truck from loading/unloading racks.***

Table 9 *EPA inspection guidelines for various tanks ("SPCC Guidance")*

It is an important best practice to reference manufacturer's specifications and instructions for use/maintenance; this is also the case for fuel tanks. As with other ASTs, this should include regular inspection of the structural soundness of a tank's shell, and the bottom/ floor via leak testing methods ("SPCC Guidance," 2011). Table 7-1 from the EPA document, “Inspection Evaluation, and Testing,” describes the inspection, evaluation, and integrity testing criteria and requirements, methods of testing for various container types, and the recordkeeping and retention requirements for tanks.

Summary of Industry Standards and Recommended Practices for ASTs				
Standard	**API 653 ^130**	**STI SP001 ^131**	**API RP 575 ^132**	**API RP 12R1 ^133**
Equipment covered	Field-fabricated, welded, or riveted ASTs operating at atmospheric pressure and built according to API 650 and API 12C.	ASTs including shop-fabricated and field-erected tanks and portable containers and containment systems with contents at atmospheric pressure and up to 200 degrees Fahrenheit (93.3 degrees Celcius)	Atmospheric and low-pressure ASTs that have been in service	Atomospheric ASTs employed in oil and gas production, treating, and processing
Scope	Inspection and design; fitness for service; repair and alterations; risk	Inspection and evaluation of ASTs	Inspection and repair of tanks	Setting, connecting, maintaining, operating, inspecting, and repairing tanks
Inspection interval	Certified inspections: dependent on tank's service history. Intervals from 5 to 30 years Owner inspections: monthly	Certified inspections: inspection intervals and scope based on tank size and configuration. Owner inspections: monthly, quarterly, and yearly	Same as API 653 and API RP 12R1	Scheduled and unscheduled internal and external inspections conducted as per Table 1 and Table 2 of the Recommended Practice, based on tank conditions
Inspection performed by	Authorized inspector, tank owner	Certified inspector (whether by API 653 with STI adjunct certification or STI) or owner's inspector	Same as API 653	Competent person or qualified inspector, as defined in recommended practice
Applicable section of this guidance	Section 7.7.1	Section 7.7.2	Section 7.7.3	Section 7.7.5

Table 10 *EPA Summary of industry standards and recommended practices for ASTs ("SPCC Guidance")*

Table 10 from the same EPA guide summarizes the major industry standards with regard to tank fabrication (field vs. shop-fabricated), inspection intervals and inspector requirements ("SPCC Guidance," 2011).

Summary of Facility Components Covered in Industry Standards for Inspection, Evaluation, and Testing										
Facility component(s) covered in standard or recommended practice	**Potentially relevant standards and recommended practices**									
	API 653	STI SP001	API 570	API RP* 575	API RP* 574	API 12R1	API 1110	ASME B31.3	ASME B31.4	FTPI RP
New equipment						√	√	√	√	
Equipment that has been in service	√	√	√	√	√	√	√		√	
Shop-built AST	√	√		√		√				
Field-erected AST	√	√		√		√				
Fiberglass reinforced plastic tanks										√
Container supports or foundation	√	√		√		√				
Diked area		√								
Aboveground valves, piping, and appurtenances		√	√	√	√		√	√	√	
Undergound piping			√		√					
Offshore valves, piping, and appurtenances									√	
*Recommended practice										

Table 11 *EPA guide to determining correct inspection regulation/practices for types of containers. ("SPCC Guidance")*

Table 11 from the same source provides further clarification on potentially relevant standards and recommended practices for certain types of tanks and other waste containers (dikes, piping, etc.) ("SPCC Guidance," 2011).

Our review of Glendale's documents concludes that all its backup generators are built to the UL 2085 construction standard. This standard includes "shop-fabricated, aboveground atmospheric Protected Tanks intended for storage of stable flammable, or combustible liquids that have a specific gravity not greater than 1.0 and that are compatible with the material and construction of the tank" (2085 Standard). Researchers determined that, since most containers "covered by STI SP001 are commonly manufactured to third-party standards, such as UL142 or UL2085," the generators and related tanks should follow inspection schedules recommended by STI SP001 (Schmidt 2013).

Table 12, from an Inspectioneering Journal article in the Callendar et al. student report, describes the inspection schedules of such tanks.

Table of Inspection Schedules				
AST Type and Capacity in US Gallons (liters)		**Category 1**	**Category 2**	**Category 3**
Shop-Fabricated ASTs	0 - 1,100 (0-4,164 liters)	P	P	P, E & L (10)
	1,101 - 5,000 (4,168-18,927 liters)	P	P, E & L (10)	[P, E & L(5), I(10)] or [P,L(2), E(5)]
	5,001 - 30,000 (18,931-113,562 liters)	P, E(20)	[P, E(10) & I(20)] or [P, E(5), L (10)]	[P, E&L (5), I(10)] or [P, L(1), E(5)]
	30,001 - 75,000 (113,566-283,906 liters)	P, E(20)	P, E&L(5), I(15)	P, E&L(5), I(10)
Portable Containers		P	P	P**
P - Periodic AST inspection (PI) E - Formal External Inspection by certified inspector (FEI) I - Formal Internal Inspection by certified inspector (FII) L - Leak test by owner or owner's designee (LT) ( ) indicates maximum inspection interval in years, For example, E (5) indicates formal external inspection every five years				
** Owner shall either discontinue use of portable container for storage or have the portable container DoT (Department of Transportation) tested and recertified per the following schedule (refer to Section 9.0): Plastic portable container - every 7 years Steel portable container - every 12 years Stainless Steel portable container - every 17 years				

Table 12 *SP001 recommended inspection schedule by tank type and size (Schmidt 2013)*

Certain facilities allow for hybrid programs, creating a personalized inspection schedule. As defined in the EPA SPCC manual: "If a Tier II qualified facility owner or operator chooses to develop an alternative inspection program rather than follow an applicable industry standard, then he must have a Professional Engineer (PE) certify environmentally equivalent measures as described in §112.6(b)(4). A Tier I qualified facility owner or operator cannot deviate from applicable industry standards when following the requirements for Tier I qualified facilities in §112.6(a)." ("SPCC Guidance" 2011, retrieved from the Callender et al. student report).

Diesel Fuel Quality

The age of diesel fuel can be problematic for backup generator fuel tanks. Factors such as heat and presence of water in the tanks affects fuel longevity. The expected life of the fuel is based on the oxidation stability test from ASTM D2274 ("American Society for Testing and Materials" 2014) which tests how much gum and sediment will be deposited after burning the fuel at 95°C with oxygen gas for 16 hours. Based on the analysis from British Petroleum oil, this corresponded to a one-to-two-year lifespan under good conditions, including ambient temperatures of 20°C. When the ambient temperature is >30°C, fuel deteriorates within 6 to 12 months. In Glendale, temperatures average >30°C for about half of the year. However, it is possible to extend the lifetime of fuels.

The most important regular maintenance practice is to remove water and sediment from the tanks. New tank installations should follow a weekly check for the presence of openings that allow infiltration of contaminants. After verification of tight seals, the frequency of water and sediment inspection may be increased to quarterly. Once every 10 years, tanks should be emptied and completely cleaned. Samples of the fuel can be visually checked on site for sediment, darkening, or haziness. **There are additive chemicals to improve the diesel fuel longevity.** Metals like zinc and copper cause fuel decomposition. Metal deactivators and antioxidants are available, and fuel stabilizers and biocides can extend fuel life.

Contractors follow the standard practice of checking tanks on a backup generator (Callender et al., p.15). Glendale requires back-up generator contractors to inspect tanks annually and maintain a record of inspections. Cummins Contractors performs such annual inspections. In addition to inspections, Western States Petroleum conducts quarterly maintenance of the fuel tanks using a tool called a VP Snake to check and remove water and sediment.

Fuel Tank Program Recommendations

- To determine correct inspection schedules, refer to the manufacturer's instructions and the tank construction standard (Callender et al., p.16).
- **Allow a hybrid inspection program,** but only under the guidance of a certified PE (Callender et al., p.16).
- Refer to the tables in the analysis section to determine testing criteria for each tank, which must be evaluated individually. Determine the testing criteria based on manufacturer's recommendations, fabrication/ installation methods (shop vs. field-erected), material, size, and specific gravity of the contained substance (Callender et al., p.16).
- Use STI-SP001 for inspection standards for diesel fuel (Callender et al., p.16).
- Consider creating a hybridized standard for other substances stored onsite since SP001 only covers storing stable, flammable, and combustible liquids at atmospheric pressure with a specific gravity <~1.0 (Callender et al., p.16).
- Calculate total oil storage capacity annually to ensure compliance with SPCC rules.
- The SPCC rule only applies when the total aboveground oil storage capacity is >1320 gallons of oil. Though this plan is intended for fuel tanks <1320 gallons, the total amount of fuel at each facility should be calculated regularly (Callender et al., p.16).
- Store general secondary containment material, such as absorbents, near areas where oil or chemical spills are most likely to occur, commonly during the transfer between containers. Rapid containment of spills will prevent contamination of water sources (Callender et al., p.16).
- **Use non-flammable containers for fuel storage.** This includes material such as steel alloys (Callender et al., p.16).
- Perform routine maintenance inspections as implemented by contractors. These inspections include quarterly maintenance of the fuel and a six-month visual testing. Glendale should supplement contractor inspections with more frequent staff inspections (Callender et al., p.16).
- Ensure that wastes removed from each facility by a contractor are properly disposed or recycled (Callender et al., p.17).

- Keep a record of all maintenance activities and inspections (Callender et al., p.17).
- Per EPA Power Resilience Guide, "…when you change the oil in your generator, consider sending a sample to be tested for the presence of metals. Metals could indicate engine wear, which may indicate that other repairs are needed." This protocol aims to ensure optimal performance in any case of an emergency (Callender et al., p.17).
- The backup fuel generators should be started and operated twice annually to ensure stability and performance efficiency in case of an emergency. Generators must perform as expected during unexpected power outages (Callender et al., p.17).
- Replace diesel fuel at least once a year, especially after the summer months due to the high heat and possible infiltration of dust and water (Callender et al., p.17).

To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCGlendaleStorageTanks

CONCLUSION

The City of Glendale manages several ASTs that fall outside the scope of those regulated by RCRA or the SPCC requirements. However, best practices created and put to use by other entities can guide Glendale toward an efficient, safe, and effective AST management program. Through their research, the students in ERM 401/501 and EGR 427 compiled recommendations on permit conditions, tank O&M, and inspection requirements. Their research and recommendations will assist Glendale in bolstering their AST Management Plan across all facilities, ensuring continued tank functionality, condition, and safety.

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To access the original student reports, additional materials, and resources, visit:

links.asu.edu/PCGlendaleStorageTanks

GLOSSARY OF TERMS

Aboveground Storage Tank (AST)

Glendale, Arizona, manages several ASTs containing a variety of hazardous materials, most notably hydrofluosilicic acid, diesel fuel, sodium hydroxide, and sodium hypochlorite. Tanks range in capacity from 55 to 20,000 gallons and in material from metal to plastic (Schneider et al., p.3).

Maricopa County Air Quality Permit to Operate and/or Construct (MCASQD)

MCAQD requires certain facilities to obtain a permit for odors, gaseous emissions, and regulated air pollutants. Glendale has facilities required to obtain air pollution control permits. The Air Quality Permits require facilities to ensure that devices related to chemical deodorizers such as sodium hydroxide and sodium hypochlorite are correctly installed, operated, and maintained. This includes tanks containing the chemicals. The Arrowhead Water Reclamation Facility (WRF) and Cholla Water Treatment Plant (WTP) have MCAQD Air Quality Permits to Operate and/or Construct (2017 and 2015, respectively). These two permits specifically were reviewed as part of this project, but there are other air permits issued to Glendale facilities (Schneider et al., p.6).

American Petroleum Institute STD 653 (API STD 653)

The American Petroleum Institute (API STD 653, 2001) presents standards for inspecting, repairing, altering, and reconstructing carbon and low alloy steel tanks. These standards apply to any tank constructed according to tank specifications. Of interest are its sections on evaluating tank shells and bottoms for the potential of corrosion, thickness, and failure (Section 4) and internal and external inspections (Section 6) (Schneider et al., p.6).

Arizona Department of Forestry and Fire Management (ADFFM)

ADFFM requires that facilities planning to install ASTs submit a site plan showing the locations of tanks and distances from buildings, property lines, ignition sources, and driveways (Permitting/Installation Requirements for AFTs, 2015). Requirements also include spill and overfill protection, signage, and security (Schneider et al., p.6).

Emergency Planning and Community Right-to-Know Act (EPCRA)

EPCRA (42 USC 116) was enacted to decrease the likelihood of disastrous releases of hazardous chemicals and to increase the public's knowledge of, and access to, information on those chemicals. The Act requires facilities to have Safety Data Sheets (SDS) for all hazardous materials present and maintain emergency and hazardous chemical inventory forms. Glendale uses hazardous chemicals in quantities that trigger EPCRA's applicability. The City has emergency plans for its facilities where quantities of hazardous materials may reach the reportable quantities listed in the EPA List of Lists or threshold planning quantities listed in EPCRA. Glendale submits the required Tier II reports each year (Schneider et al., p.7).

International Fire Code (IFC)

Glendale's Fire Department has adopted the IFC, including Appendix Chapter B, 2009 Edition. This code requires any entity that stores, transports on site, dispenses, uses, or handles hazardous materials equal to or above the amounts listed in IFC Table 105.6.21 (see Appendix A of Schneider report, p.28) must obtain a Hazardous Materials Permit (Hazardous Material Management Plan, n.d.). The Fire Department also requires a fire permit for Flammable/Combustible Liquids, based on the facility's HMIS (Schneider et al., p.7).

National Fire Protection Association 30 (NFPA 30)

NFPA 30 (2018) contains the flammable and combustible liquids code. The sections of interest are liquid classification and flash points for use in determining applicability (Chapter 4) and the storing, handling, and transporting of flammable liquids (Chapters 9, 18, 21, and 22). Relevant topics include appropriate containers, drainage and spill control, design and construction requirements for tanks, and inspection and maintenance of ASTs (Schneider et al., p.7).

National Fire Protection Association Standard 326 (NFPA 326)

NFPA 326 (2015) covers the safeguarding of tanks and containers for entry, cleaning, or repair. These tasks include the emptying of hazardous materials, inspections and certifications, and cleaning inspections (Schneider et al., p.8). NFPA 326 also outlines storage life for ASTs, which, for unused and properly stored diesel fuel, ranges from 1.5 to 2 years. Although this document was written in 1996, it is still often cited for emergency power references (Callender et al., p.6).

National Science Foundation American National Standards Institute 61 (NSF ANSI 61)

ANSI 61 (2016) sets the standard for drinking water systems that have contact with drinking water or treatment chemicals. These components include joining and sealing products, plumbing products (valves and faucets), and chemical storage tanks (Schneider et al., p.8).

Occupational Safety and Health Administration (OSHA)

OSHA regulations for confined space entry are in 29 CFR (Code of Federal Regulations) 1910 Subpart J. When tanks, defined as confined spaces, contain a safety or health hazard, they require a permit before entry to perform work, such as cleaning or an internal inspection. OSHA requires employers to have a written hazard communication program. This program should describe how requirements about forms of hazard warning, employee informing, and employee training will be conducted in the workplace. Safety Data Sheets (SDS) are required for each hazardous chemical (29 CFR 1910.1200(e)). OSHA has many other regulations about the general industry, including fire detection and protection, personal protective equipment, flammable and combustible liquids, emergency action plans, and lockout/tagout procedures. The HazWOpER requirement covers hazardous waste management and spills (Schneider et al., p.8).

Steel Tank Institute/Steel Plate Fabricators Association (STI/SPFA ST001)

The Institute published a standard for AST inspections (ST001 2018). Before entering an AST, the tank owner and contractor should develop an Emergency Action Plan that includes safety requirements, such as personal protection equipment, escape routes, and rescue and first-aid duties (Schneider et al., p.9). Section 5.4 categorizes tanks; Section 5.5 designates inspections; Sections 6-8 detail guidelines for periodic inspections, Formal External Inspections, and Formal Internal Inspections, respectively. See Appendix A, Inspection Checklists in Schneider et al. report, p. 31-34.

The National Association of State AST Programs (NASAP)

NASAP, a group of representatives from state AST regulatory agencies, is compiling a list of each state's AST program, which includes a link to the program, information on its codes/regulations, and a program summary, including what materials they regulate (NASAP 2019). Once compiled, this list will be a good reference for states and cities. The students' review of the NASAP website discovered no significant improvement over the federal requirements. However, the website should be monitored for updates on the pending report (Kemp et al., p.9).