

TECHNICAL SPECIFICATIONS: 2023 Waughop Lake Alum Treatment

PART 1 - GENERAL

1. DESCRIPTION

It is the intent of these specifications to describe the minimum acceptable performance standards for the application of aluminum sulfate (alum) and sodium aluminate to inactivate sediment phosphorus, while maintaining lake pH and alkalinity, in Waughop Lake, Lakewood, WA.

1.1. BACKGROUND

Waughop Lake is a small lake (33 acres) located in the City of Lakewood, Washington, approximately 42 miles south of Seattle, WA. Waughop Lake is the centerpiece of the popular Fort Steilacoom Park and is used for fishing (for stocked fish), model boat racing, kayaking, canoeing, and bird watching. The shoreline area is heavily used by hikers, joggers, and dog walkers. There is a newly renovated mile long asphalt perimeter walking path around the lake.

Waughop Lake has a mean depth of 7 feet (2.1 m) and an approximate volume of 271,365 m³. Waughop Lake sits in a basin surrounded by slopes to the north, south, and west, with open flat meadows to the east. The lake's catchment area is approximately 497 acres with contributing surface drainage area of about 217 acres. The Pierce College campus covers about 66 acres. A residential area of approximately 130 acres which is served by septic systems lies southwest of the lake.

No creeks or other natural surface water channels flow into the lake. Stormwater runoff from a portion of Pierce College campus is conveyed through a pipeline to the lake. There are no natural or man-made outlets to the lake and water leaves the lake via seepage and evaporation. Waughop Lake is a glacial kettle lake that appears to be in direct contact with the shallow groundwater-flow system.

Waughop Lake has a long history of toxic cyanobacteria blooms. Health advisories issued by the Tacoma-Pierce County Health Department have been common for Waughop Lake during the past 10 years. In June 2010, the health department issued an advisory not to eat fish from the lake and for a short period of time in 2011, toxin concentrations were so high that the lake was closed to all uses. Since 2007, toxicity data have been collected and maintained by Ecology on its Washington State Toxic Algae website. Of the 195 water samples collected from Waughop Lake from July 2007 to September 2018, 141 exceeded the state recreation guideline value for microcystin (6 µg/L).

The City of Lakewood has made the protection and restoration of Waughop Lake a high priority and has decided to treat the lake with alum to provide aluminum to inactivate sediment phosphorus (P) and reduce P concentrations in the lake. This will lead to a reduction in cyanobacteria production and improved recreational use of the lake. The total alum dose for Waughop Lake is no more than 120 mg Al/L. This dose is based on inactivating the average P concentration in the top 45 cm of sediment that is most likely

to be available for internal loading and subsequent cyanobacteria growth. Mobile sediment P concentrations in Waughop Lake are relatively high due to past practices of discharging manure and other agricultural wastes into the lake. This dose will inactivate a significant amount of sediment phosphorus, strip phosphorus from the water column, and provide the most cost-effective strategy for reducing toxic algae blooms.

Current sediment conditions within the top 45-50 cm (average water content 92%) require that the alum dose (120 mg Al/L) be applied to the lake in separate applications, over the course of several years, depending on effectiveness monitoring and lake condition. This will allow the sediment to consolidate from its current very fluid state and maximize the effectiveness of the treatment.

The first application, at 40 mg Al/L, occurred in late March 2020 and was followed by another application, at the 40 mg Al/L dose, in the middle of July 2020. The 3rd application, at a dose of 20 mg Al/L is slated to occur in early summer 2023. A 4th treatment of another 20 mg Al/L may be necessary 2 to 3 years following the 2023 treatment. The City of Lakewood will evaluate monitoring data following the 2023 treatment to determine if and when another treatment may be necessary.

Work on-site shall generally occur between 7 AM and 6 PM, Monday thru Friday. Work on weekend days and holidays shall not be allowed.

2. PROJECT SPECIFIC REQUIREMENTS

Below is a list of project specific requirements for the 2023 Waughop Lake Alum Treatment.

- A. The Contractor shall perform all work necessary to apply liquid aluminum sulfate (alum) and liquid sodium aluminate (buffer) simultaneously at a volumetric ratio of 1.8:1 (alum: sodium aluminate) for phosphorus control in Waughop Lake. A ratio of 1.8:1 will provide approximately 0.22 kg Al from 1.8 gallons of liquid alum and approximately 0.4 kg Al from one gallon of liquid sodium aluminate, given a concentration of 25.5 to 32% for the available soluble sodium aluminate. Materials shall be applied to the whole lake, beginning with the shallower portions of the lake (less than 5 ft and finishing in the deeper section of the lake at the northeast end. Note: The City of Lakewood holds permit coverage for this treatment under the Washington State Department of Ecology Aquatic Plant and Algae Management General Permit for this treatment. The contractor shall adhere to all the requirements of Ecology General Permit and keep a copy of the permit on the treatment vessel at all times.
- B. The Contractor shall provide all equipment, labor, and materials necessary to perform the work, including application equipment, and all other equipment necessary to mobilize and demobilize. This shall include, but not be limited to:
 1. The specified amounts and qualities of aluminum sulfate and sodium aluminate;
 2. Boat(s) or barge(s) capable of traversing the lake and applying the alum and buffer at appropriate rates to all portions of the lake. Both chemicals are to be

applied to the water directly and simultaneously, yet separately, so that they mix immediately upon entering the water but not before (see Exhibit C for illustration of appropriate application boom set up). The alum and sodium aluminate should NOT come in contact with one another outside of the water.

3. On-shore chemical storage tanks and associated spill containment equipment, if necessary, (on-shore chemical storage is required by the permit for any treatment requiring 9,000 gallons of alum or more unless the contractor has a plan to store any unused alum or buffering agent or if the rate of application can keep pace with delivery of chemicals);
 4. On-board chemical storage tanks and spill containment equipment;
 5. The appropriate pumps, boom and spreader applicators to control and evenly distribute chemical dosing for both liquid aluminum sulfate and sodium aluminate simultaneously; (See Exhibit C for illustration of appropriate boom set up. Note that the chemicals are to be delivered to the lake water at an approximate depth of 1 to 2 inches below the water surface from a minimum of 12 pairs, up to a maximum of 24 pairs, of alum and sodium aluminate injection tubes (nozzles or small hoses) spaced 8 to 12 inches between pairs and with the alum and sodium aluminate injection tubes within each pair spaced 2 to 4 inches apart. The injection tubes shall be alternating so that the closest tubes in each direction are always tubes of the other chemical. The treatment shall not begin until the application system is approved on-site by the person(s) representing the City of Lakewood.)
 6. A GPS-linked computer system for barge (boat) guidance that is integrated with real-time bathymetric measurements and provides chemical dosing control for both aluminum sulfate and sodium aluminate pumping rates based on real-time depth as well as maps/documents areas of the lake already treated; and
 7. Trained staff to safely and effectively implement the alum treatment.
 8. Any temporary ramp structure(s) (if needed) that meets ADA accessible route requirements, to facilitate normal and continued use of the lake's perimeter path and walkways during treatment application activities.
- C. Environmental conditions may exist at Waughop Lake that may require delay or temporary interruption of work on the project. The City of Lakewood's on-site representative will make a final determination on whether to initiate, suspend, or re-start the treatment, based on having acceptable environmental conditions for treatment. These conditions shall include but are not limited to: dissolved oxygen, pH, temperature, wind, intensity of phytoplankton bloom, and fish kill. Delays or postponements may be measured in hours or days, depending on the length of time necessary for conditions to improve. All work shall comply with conditions of the permit coverage for this project.

The general configuration of the lake and bathymetry and the staging area are shown on Exhibit A and Exhibit B.

3. SUBMITTALS

The contractor shall submit the following for review and approval by the City of Lakewood and their on-site representative.

- A. Plan of Work – shall be submitted as part of the bid submittal package and prior to the procurement of materials and shall include, at a minimum, the following items:
 1. Explanation of plans and schedule for the timely delivery, storage and transfer of all chemicals;
 2. Description of any temporary on-shore chemical storage facilities (if utilized) and spill containment and proposed location for security fencing and/or other measures deemed necessary to deter vandalism and prevent tampering with chemical storage facilities;
 3. Photographs and/or drawings and description of the application equipment to be used on the lake, including application boom set up, width of application path, on-board storage capacity of both chemicals, storage and application equipment material, and means of locomotion;
 4. Description of approach to application in the shallow areas of the lake, with specific reference to how to move the treatment boat around in these areas and the application technique to apply the chemicals within these shallower areas, if different than the application technique to be used in deeper areas of the lake;
 5. Method of chemical distribution, documenting the control of chemical pumping rate into the lake based on application vessel speed, real-time GPS navigation, and real-time bathymetric measurements to ensure an effective dose of 20 mg Al/L throughout the lake during each application;
 6. Description of any proposed backup systems to minimize down time;
 7. Description of land-to-vessel chemical transfer method(s), including spill prevention and response protocols to be employed;
 8. Anticipated treatment capacity (acre/hour and gallons/day);
 9. Plan for decontaminating all equipment prior to bringing equipment to the lake to prevent the introduction of any aquatic invasive species into the lake. This includes, but is not limited to, de-contamination of barge(s), boat(s), boat and vehicle trailers and tires, all on-board gear, hoses, pumps, spreader lines, booms, barge/boat motors, personal gear such as boots, and any on-shore equipment or gear, including storage tanks, that could come in contact with lake water or allow aquatic invasive species to be washed into the lake. Minimum decontamination procedures are the Washington State Department of Fish and Wildlife Invasive Species Management Protocols, Level 1 Decontamination Protocol – Basic and, if the equipment is known to have been exposed to aquatic invasive species, Special Protocols – Boats and Other Large Aquatic Conveyances Transported Overland. These protocols may be found at

<http://wdfw.wa.gov/publications/01490/wdfw01490.pdf>

10. Spill prevention, control, and contingency plan. (SPCC Plan);
11. Emergency contact information;
12. Shop drawings for any temporary path bridge/ramp structure (or provide construction detail on plans);
13. Product data for all products used (list submittal requirements or per **Part 2 Products and Materials** listed below).

B. Application Log – Shall include, at a minimum, the following items:

1. Date of work.
2. Daily starting time and ending time, hours of application
3. Workforce
4. Weather conditions
5. Quantity of material applied (gallons); computer data indicating application of liquid alum and sodium aluminate in the specified dose ratio
6. Approximate location and each day's application path (on map) and acreage of treatment
7. Summary of truck deliveries, including percent Al in both alum and sodium aluminate delivered as well as the percent of soluble sodium aluminate in the liquid sodium aluminate delivered.
8. The Contractor shall provide the City of Lakewood and their on-site representative with the manufacturer's material quality assurance certification with each truck delivery to show that procurement meets specifications. The alum and sodium aluminate in each delivery shall be approved by the City of Lakewood's on-site representative prior to any offloading or applying the alum and/or sodium aluminate in Waughop Lake.

These logs shall be submitted to the City of Lakewood's on-site representative at the end of each day except for item 8 that will be submitted at the time of chemical truck delivery for both alum and sodium aluminate to site for each truck before any offloading can occur.

4. QUALIFICATIONS

- A. To be awarded this project, the Bidder shall provide satisfactory evidence that the Bidder meets the qualification requirement listed below. Such evidence as statement of qualifications must be submitted with bid documents and should include names and contact information for at least 3 project references in the state of WA.
1. The contractor must have conducted buffered, whole-lake alum treatments in a minimum of three lakes that are 100 surface acres or more in size, within the last five years. Chemical application experience on these projects should include application of alum as the nutrient

inactivation and sodium aluminate as the buffering agent.

- B. The Bidder must provide their proposed Plan of Work (see Part 1, Section 3.A. Submittals) as part of their bid submittal package.

PART 2 – PRODUCTS AND MATERIALS

1. ALUMINUM SULFATE (ALUM)

- A. Upon approval by the City of Lakewood, the contractor shall procure **12,340** gallons of liquid aluminum sulfate ($\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$) for the application to Waughop Lake in early summer 2023, preferably June. Alum shall meet the following specifications:
 - 1. Grade = Drinking Water Treatment Grade;
 - 2. pH = 2.0 to 2.4;
 - 3. Specific Gravity at 70°F = 1.333 to 1.337;
 - 4. Freezing Point = -16°C;
 - 5. Boiling Point = 101°C (214°F);
 - 6. Total Water-Soluble Aluminum of 4.2 – 4.4% or as Al_2O_3 , 8.0 to 8.4%.
- B. The total water-soluble iron (expressed as Fe_2O_3) content of aluminum sulfate shall be no more than 0.02 percent, on a basis of 8.1 percent Al_2O_3 in liquid alum. In liquid alum, the water-insoluble matter shall not exceed 0.02 percent. At a minimum, aluminum sulfate shall conform with the “American National Standards Institute/National Sanitation Foundation” (ANSI/NSF) Standard 60 Drinking Water Treatment Chemicals – Health Effects (2005 and previous), or Standard 61 Drinking Water System Components – Health Effects (2005 and previous) for use in drinking water.
- C. The aluminum sulfate supplied shall contain no soluble mineral or organic substances in quantities that are capable of producing deleterious or injurious effects on public health or water quality and shall be drinking water treatment grade.
- D. The Contractor shall provide the City of Lakewood and their on-site representative with the manufacturer’s material quality assurance certification with each truck delivery to show that procurement meets specifications. The alum in each delivery shall be approved by the City of Lakewood’s on-site representative prior to applying the alum in Waughop Lake.

2. SODIUM ALUMINATE

- A. Upon approval by the City of Lakewood, the Contractor shall procure **6,790** gallons of liquid sodium aluminate of approximately 25.5 to 32% available soluble sodium aluminate and up to 38% available soluble sodium aluminate for the application to Waughop Lake in early summer 2023.

- B. Sodium aluminate (NaAlO_2) is produced from the reaction of alumina tri-hydrate with caustic soda. Liquid sodium aluminate shall contain no more than 0.5 percent insoluble matter. Liquid sodium aluminate shall contain a minimum of 25.5 to 32% available soluble sodium aluminate to a maximum of 38%. If liquid sodium aluminate procured by the contractor contains more or less than 25.5 to 32% available sodium aluminate, the application ratio of alum and sodium aluminate will need to be modified and quantities of sodium aluminate revised. Liquid sodium aluminate shall have excess sodium oxide of at least 4 percent to ensure complete combination with the aluminum oxide.
- C. The sodium aluminate supplied in accordance with this standard shall contain no substances in quantities capable of producing deleterious or injurious effects on public health or water quality and shall be water treatment grade and certified to meet ANSI 60 Standard for Drinking Water Additives.
- D. The Contractor shall provide the City of Lakewood and their on-site representative with the manufacturer's material quality assurance certification with each truck delivery to show that procurement meets specifications. The sodium aluminate in each delivery shall be approved by the City of Lakewood's on-site representative prior to applying the chemical in Waughop Lake.

3. ALUM AND SODIUM ALUMINATE STORAGE TANKS

- A. Temporary on-shore storage tanks may be used for staging the chemicals to ensure that the application of alum and sodium aluminate is successfully completed in the required application time frame of 3 working days.
- B. If on-shore storage tanks are used, separate tanks shall be provided for each chemical.
- C. All on-shore storage tanks shall be fabricated out of HDPE or other suitable material, i.e. stainless steel that is tolerant of temperature in excess of 200 degrees F.
- D. The Contractor shall check and confirm the volume of alum/sodium aluminate required for the specified dose prior to procurement of any storage tanks.
- E. The Contractor shall provide secondary containment to help prevent spills or uncontrolled leakage of materials from on-shore storage facilities. Spill containment must provide the following features and be equal to or better than "Spillguards":
 - 1. Puncture resistant;
 - 2. One piece, no assembly required;
 - 3. Wind resistant;
 - 4. Approved for a temperature range of -40 to 200 degrees Fahrenheit.

4. ALUM AND SODIUM ALUMINATE DISTRIBUTION SYSTEM

- A. The Contractor shall procure alum and sodium aluminate distribution lines, pumps, injector units, and all other pertinent equipment necessary to deliver the prescribed liquid alum and sodium aluminate.
- B. All piping shall be heavy duty HDPE or appropriate material to avoid dissimilar metals corrosion and to provide safety relative to chemical temperature and potential leaks.
- C. Type 316 stainless-steel fittings shall be used in areas where contact with liquid alum and/or sodium aluminate is anticipated. All couplings and connectors used for alum and sodium aluminate distribution lines, storage tank, pumps, and injector units must meet corrosion resistance standards for alum and sodium aluminate, i.e. type 316 stainless-steel fittings at minimum.

PART 3 – EXECUTION

1. Preparation

- A. The Contractor shall protect structures, utilities, sidewalks, roadways, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, or other hazards created by work associated with the application of liquid alum and sodium aluminate, including but not limited to, the transport and delivery of chemicals, chemical storage tanks, and chemical spills. During and at the completion of the application of liquid alum and sodium aluminate, the Contractor shall conduct all operations in such a way as to:
 - 1. Comply with any and all permit conditions for this project;
 - 2. Prevent damage to the lake, equipment, and surrounding properties;
 - 3. Prevent damage to the aquatic environment by using a biodegradable hydraulic fluid;
 - 4. Prevent damage to the lake by ensuring that no aquatic invasive species are introduced into the lake. This shall include decontaminating all equipment and gear that will come into contact with lake water prior to bringing such equipment to the staging area.
 - 5. Maintain orderly appearance at the work site while the treatment is occurring;
 - 6. Prevent damage to the aquatic environment by implementing temporary erosion and sediment control measures, if directed by the City of Lakewood; and
 - 7. Prevent damage to the aquatic environment if temporary on-shore storage tanks are used.

2. Staging Area

- A. The Contractor shall be responsible for all staging area setup, security, cleanup, and restoration to its original condition following completion of the application. The staging area will be left in the same condition as before the operation began, photo-documented

and verified by the City of Lakewood and their on-site representative prior to the acceptance of work.

- B. The staging area is located at an access point along the east shore, near a small picnic shelter, along the paved walking path (Exhibit B). Specific park user access restrictions plus temporary traffic controls (i.e., when chemical truck arrives at the site), as well as, park user area restrictions may be modified on-site based upon the direction by City of Lakewood's project representative. The staging area is located within a public park. The Contractor shall take steps to minimize impacts to park and lake users in noise, parking, safety, equipment and supply storage, smells, chemical contact and general condition of the site. The Contractor shall place security fencing around all equipment and storage tanks remaining on-site during non-working hours.
- C. The staging area can be accessed via park maintenance roadways which are normally gated off from vehicular traffic. There is a large parking lot approximately 400 ft to the northwest of the staging area (see Exhibit B) that could potentially be used by chemical delivery trucks, if access is restricted at the proposed staging area.

3. Application

- A. Each application of the alum and sodium aluminate shall take place after the lake water temperature has risen to over 5.5°C (42° F) throughout the water column. The preferred time frame for the application is June 2023. The application from start to finish shall be completed within 3 working days, with one additional day for mobilization and another additional day for demobilization. Applications will take place only when the wind speed is less than 15 mph at the lake surface.
- B. A mixture of water treatment grade liquid aluminum sulfate (alum as $\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$) and liquid sodium aluminate ($\text{Na}_2\text{Al}_2\text{O}_4$) shall be applied to the lake surface or injected into the lake from a moving barge or boat. The barge/boat position in the lake shall be controlled by a satellite guiding system (GPS) with computer integrated depth sonar to continuously adjust the application rate of liquid alum and sodium aluminate mixture (1.8 gallons alum to 1 gallon sodium aluminate, assuming 25.5 to 32% soluble sodium aluminate concentration) based on changing lake depth and boat speed. All areas of the lake will be treated at 20 mg Al/L during each application. This will ensure complete and uniform chemical coverage during each application. All application path and dosing will be recorded electronically and made available (both in graphical and tabular form) at the end of each day to the City of Lakewood's on-site representative.
- C. The Contractor shall employ a treatment barge (boat) with on-board chemical storage tanks and applicator for even chemical distribution. The system of chemical distribution shall have a minimum application rate of 40,000 gallons per day of combined alum and sodium aluminate. The boom system for chemical distribution shall be substantially similar to the illustration in Exhibit C. The chemicals are to be delivered to the lake water at an approximate depth of 1 to 2 inches below the water surface from a minimum of 12 pairs, up to a maximum of 24 pairs, of alum and sodium aluminate injection tubes (nozzles or small hoses) spaced 8 to 12 inches between pairs and with the alum and

sodium aluminate injection tubes within each pair spaced 2 to 4 inches apart. The injection tubes shall be alternating so that the closest tubes in each direction are always tubes of the other chemical. The treatment shall not begin until the boom system is approved on-site by the City of Lakewood's on-site representative.

- D. The Contractor shall apply a full chemical allotment of liquid alum and liquid sodium aluminate to Waughop Lake. The effective dose of aluminum to be applied to the lake shall be 20 mg Al/L within the water column of the entire lake.
- E. The full chemical allotment, as defined above, shall be applied in a ratio of 1.8 gallons alum to 1 gallon sodium aluminate (assuming 25.5% to 32% soluble sodium aluminate concentration) with an accuracy of ± 3 percent. The chemicals must be simultaneously distributed so that the entire treatment area is uniformly covered, starting with the shallow areas and finishing in the deeper section of the lake. Computerized barge (boat) guidance and chemical metering control shall be used to ensure that the chemicals are distributed simultaneously and in the correct ratio.
- F. In accordance with the alum treatment permit coverage issued to the City of Lakewood by the Washington State Department of Ecology, the lake pH will be monitored by City of Lakewood on-site representatives in surface water samples collected 0.5 m below the lake surface and at 0.5 m above the lake bottom each morning before application begins, one (1) hour following application each day, and during the duration of the application.
- G. Prior to beginning the lake alum treatment (0.5 to 48 hours before), the Contractor will conduct a jar test at the lake in a bucket or barrel using alum and sodium aluminate at 20 mg Al/L and a ratio of 1.8 gallons alum to 1 gallon sodium aluminate to verify that treated water is above pH 6.0 and below pH 8.4 after addition and mixing (0.25 to 0.5 hours after being dosed).
- H. Work shall be suspended if the pH of lake water is consistently less than 6.2 (± 0.05) or greater than 8.7 (± 0.05) in the collected water samples.
- I. The threshold for re-starting treatment shall be a pH between 6.2 and 8.4 (± 0.05).
- J. The Contractor shall apply the full chemical allotment of alum and sodium aluminate as defined above. If there is a remaining supply of chemical after the Contractor has applied the specified dose due to minor deviations in dosage or in lake bathymetry, the Contractor shall be responsible for applying the remaining amount of chemicals to the lake uniformly in areas between 5 and 10 ft depth at the specified ratio of 1.8 gallons alum to one gallon sodium aluminate. Note: if at any time the pH of the lake water is less than 6.2, treatment is to be immediately stopped until pH is greater than 6.2 and the on-site representative of the City of Lakewood gives approval to proceed with the application.
- K. The Contractor shall submit the Application Log at the end of each day for review by the City of Lakewood and their on-site representative.

4. Hazards

- A. Because the application of liquid alum and sodium aluminate will take place in a lake, several potential hazards exist, including docks, boats, and underwater hazards such as sunken logs, debris, boats, or utilities. The contractor should use caution and good judgement during the application. The contractor is encouraged to produce a specific Waughop Lake Alum Treatment Health and Safety Plan and implement that plan with its employees. The contractor needs to have a plan to address any hazardous conditions or other unforeseen site conditions that may be encountered and is responsible and holds sole liability for safe execution of the alum treatment.

Exhibit A Waughop Lake bathymetry

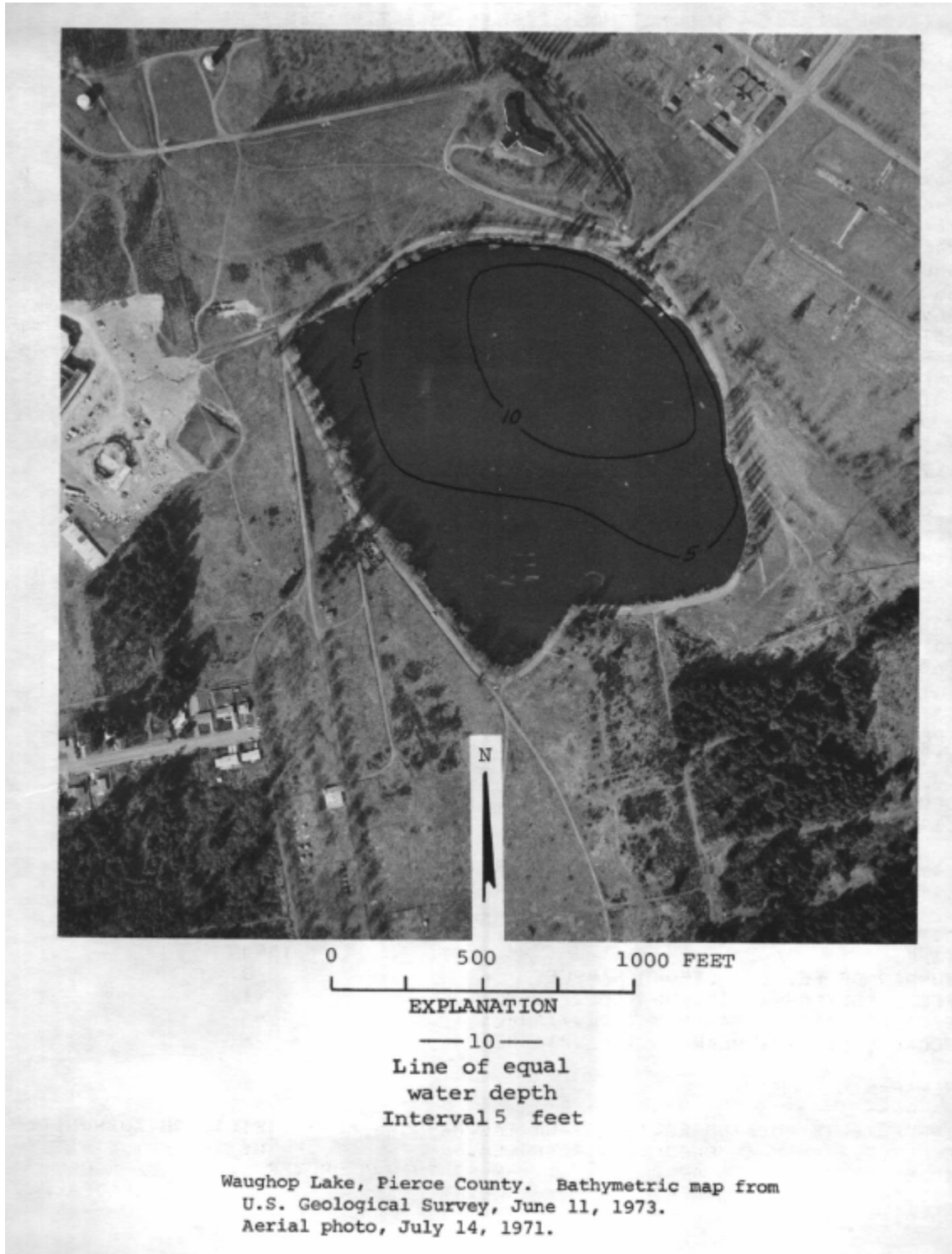


Exhibit B Staging Area



Exhibit C Chemical Distribution System Illustration

