



75 State Street, Suite 701
Boston, Massachusetts 02109
tel: 617 452-6000

May 2, 2022

Mr. Charles Dam, P.E.
Director of Public Works
10 Central Street
Manchester-by-the-Sea, Massachusetts

Subject: Manchester-by-the-Sea Lincoln Street Well – PFAS Treatment Evaluation
Executive Summary

Dear Mr. Dam:

CDM Smith Inc. (CDM Smith) is pleased to provide you with this executive summary of the Lincoln Street Well (LSW) – per- and polyfluoroalkyl substances (PFAS) Treatment Evaluation. CDM Smith evaluated treatment alternatives and made recommendations for the treatment of PFAS detected at the LSW located at 40 Lincoln Street in the Town of Manchester-by-the-Sea (MBTS), MA.

Introduction

In 2021, MBTS sampled the LSW for PFAS including the six perfluoroalkyl substances (PFAS6) currently regulated by the Massachusetts Department of Environmental Protection (MassDEP). While concentrations have remained below MassDEP's 20 nanograms per liter (ng/L) standard, MBTS commissioned this engineering evaluation to prepare a design concept for implementing treatment if PFAS concentrations continue to trend upward.

As part of the PFAS evaluation it was determined that the concentration of manganese in the raw water warrants further treatment, in lieu of sequestration currently being used, should treatment for PFAS be installed in the future. This evaluation provided a conservative, holistic approach to both iron and manganese removal as well as PFAS removal. Other, alternative approaches to addressing MBTS's water quality concerns are also presented for consideration.

Existing Operations

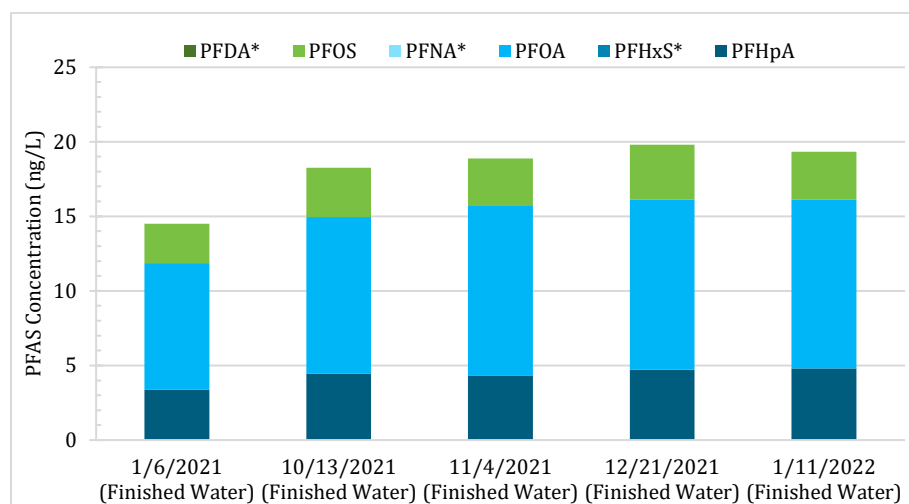
Currently, only chemical treatment is employed at the LSW. The chemical systems used include sodium hydroxide (pH adjustment for corrosion control), sodium hypochlorite (disinfection), sodium fluoride (dental hygiene), and a blended phosphate (iron and manganese sequestration). The LSW is rated for a capacity of 0.38 million gallons per day (mgd) and is operated continuously during



summer and other periods of high water demand. None of the existing systems on site are capable of removing PFAS.

Water Quality

The available data for the regulated PFAS contaminants found in LSW samples are plotted in **Figure ES-1**.



ES-1. Total PFAS Concentration in the finished water samples

Notes:

1. PFDA: Perfluorodecanoic Acid; PFOS: Perfluorooctanesulfonic Acid; PFNA Perfluorononanoic Acid; PFOA: Perfluorooctanoic Acid; PFHxS: Perfluorohexanesulfonic Acid; PFHpA: Perfluoroheptanoic Acid
2. * Indicates results are non-detect

Concentrations of iron, chloride, sulfate, and total dissolved solids (TDS) levels are below the Secondary Maximum Contaminant Level (SMCL) in the finished water. Sufficient alkalinity is present in the finished water, which is favorable for PFAS treatment using media technologies. The finished water concentration of manganese is above the SMCL of 0.05 mg/L.

Regulatory Requirements and PFAS Treatment Goal

While the state regulation only requires less than 20 ng/L in finished water, the treatment goal of half the MCL or 10 ng/L for PFAS6 is conservative and is being used for this evaluation for several reasons:

- Uncertainties associated with the federal regulations;
- The state regulatory requirement to sample finished water that exceeds 10 ng/L in PFAS6 levels; and



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- Operational considerations that go into media changeouts.

The PFAS treatment technologies should be able to remove PFAS6 to non-detect levels during initial operation.

Treatment Technologies

The following treatment technologies for the removal of PFAS were described in the evaluation: granular Activated Carbon (GAC); anion exchange (AIX) and membranes. Although other treatment technologies are included for planning purposes, a focus has been placed on the use of GAC treatment. Granular activated carbon is both a well-proven PFAS treatment technology (especially for long-chain PFAS) and is typically the largest footprint solution, thus representing a conservative basis for planning at this stage of design development.

Preliminary Design Criteria and Cost Estimate

The proposed treatment building can be seen in **Figure ES-2 and ES-3**. Assuming a conservative loading rate of 3.9 gallons per minute per square foot (gpm/sq.ft.), three (3) 7-foot diameter pressure filter vessels with manganese dioxide coated media would provide manganese removal to achieve a target concentration prior to the water contacting the PFAS treatment media. Assuming an empty bed contact time (EBCT) of 10 minutes, two, eight foot diameter GAC vessels are proposed for the 0.38 mgd PFAS removal system. The total project cost is estimated to be approximately \$9.7 million which includes a 25 percent construction contingency and a 4 annual percent escalation to the midpoint of construction (assumed in the evaluation to be April 2024). It also includes a 15 percent project contingency and a 25% engineering and implementation allowance.

Next Steps for MBTS Consideration and Recommendations

The following next steps are recommended by CDM Smith in order to advance the design of the PFAS treatment facility:

- Conduct bench-scale and/or pilot testing to confirm treatment efficacy and assess operational costs associated with media changeouts.
- Initiate pre-design task such as surveying, geotechnical investigation, and electrical system verification as these tasks do not rely on the results of bench or pilot testing.
- Develop a detailed project implementation schedule and initiate final design efforts, including required state and local permitting efforts.





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Sincerely,

A handwritten signature in black ink that reads "Michaela Bogosh".

Michaela L. Bogosh, P.E.

Project Manager

CDM Smith Inc.

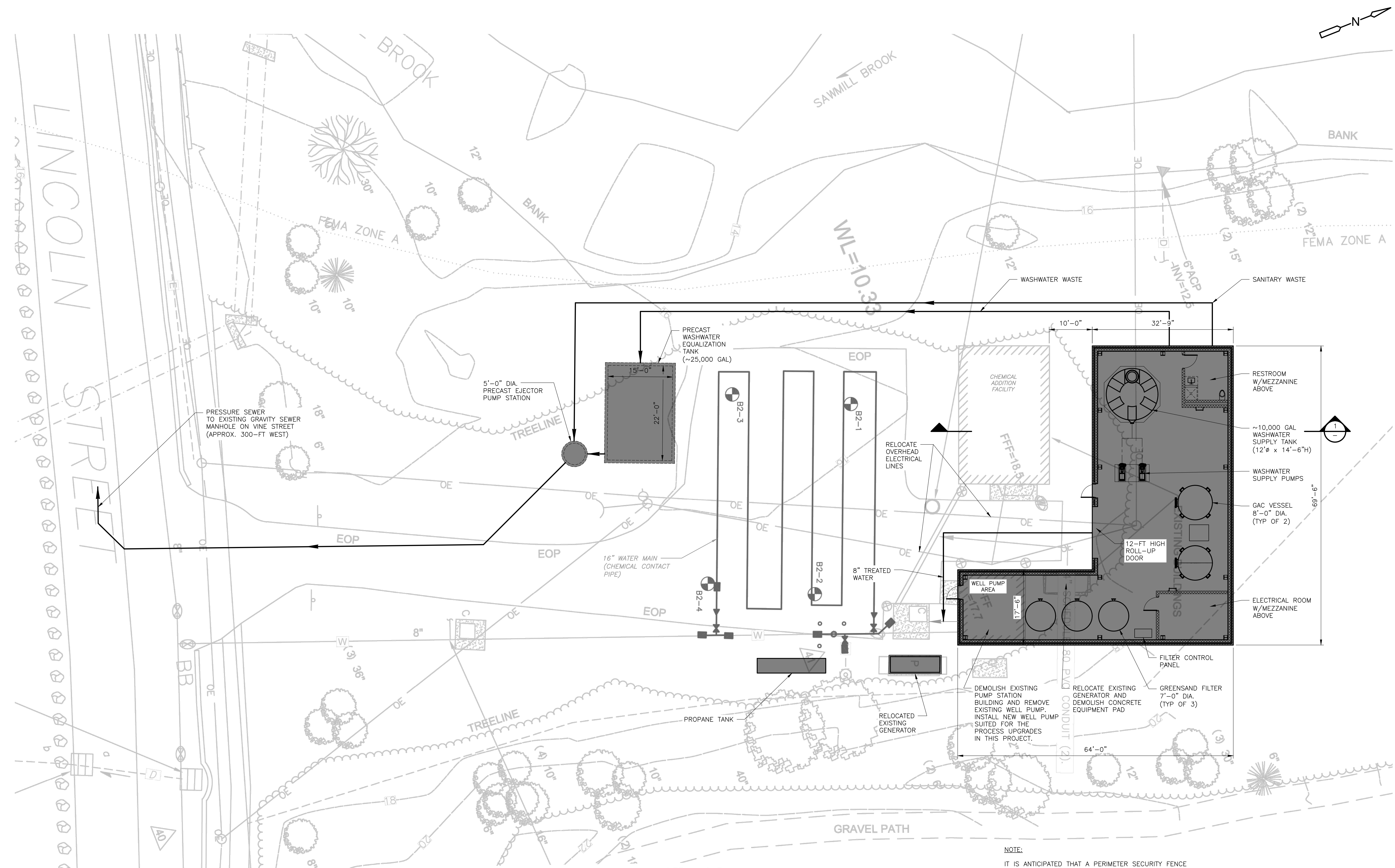
cc: Lisa H. Gove, P.E.
Alan G. LeBlanc, P.E.



May 2, 2022

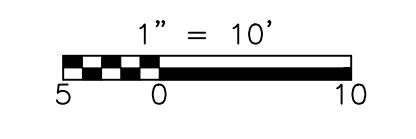


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SITE LAYOUT PLAN
 1" = 10'

NOTE:
 IT IS ANTICIPATED THAT A PERIMETER SECURITY FENCE WILL BE ADDED TO THE SITE. THE LOCATION WILL BE BASED ON THE FINAL DESIGN LAYOUT. LOCATION OF THE FENCE IS NOT SHOWN ON THIS CONCEPTUAL PLAN FOR CLARITY.



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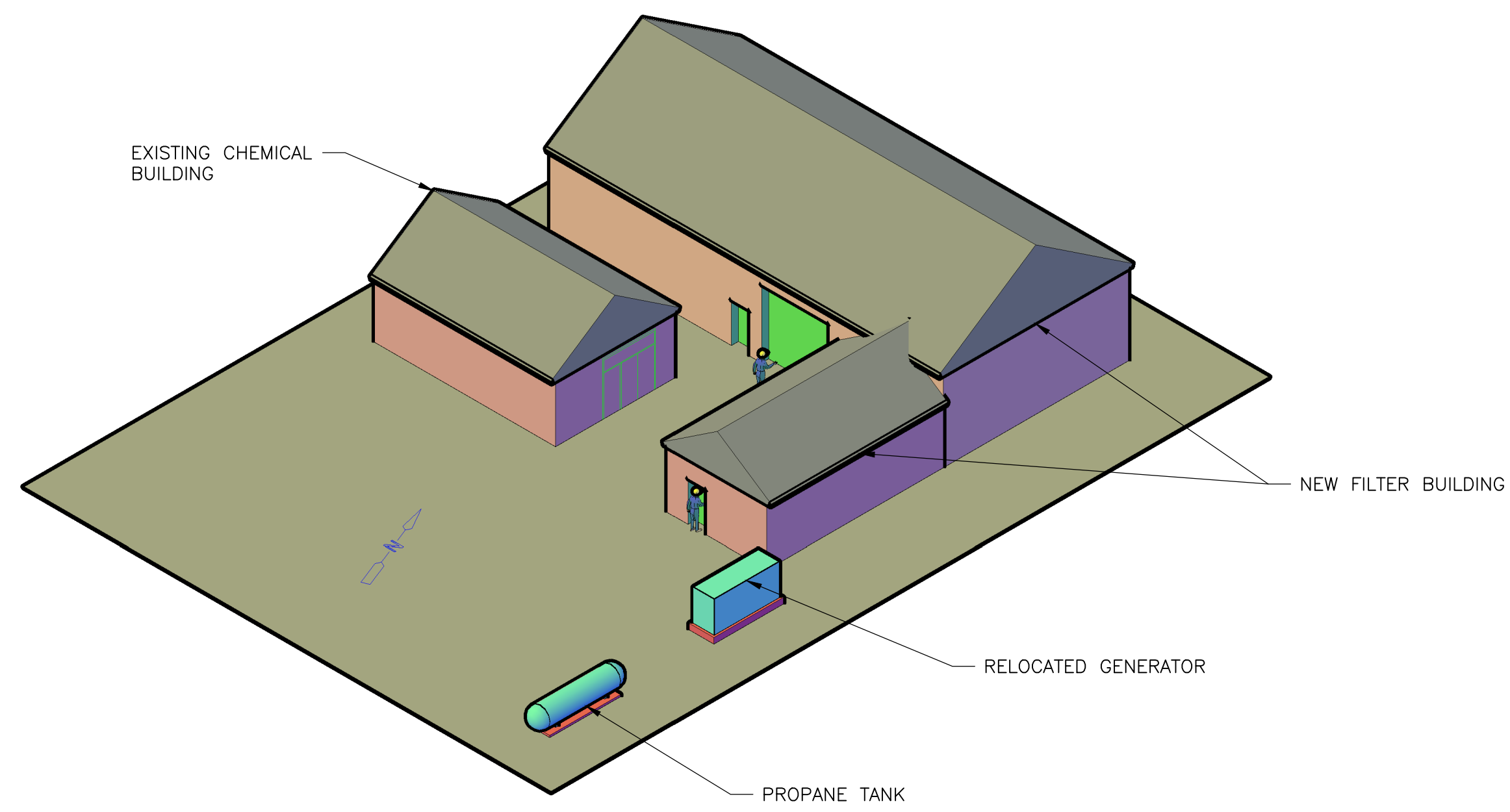
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APPROVED BY:	X
DATE:	JANUARY 2022

CDM Smith
 670 N. Commercial Street, Suite 208
 Manchester, NH 03101
 Tel: (603) 222-8300

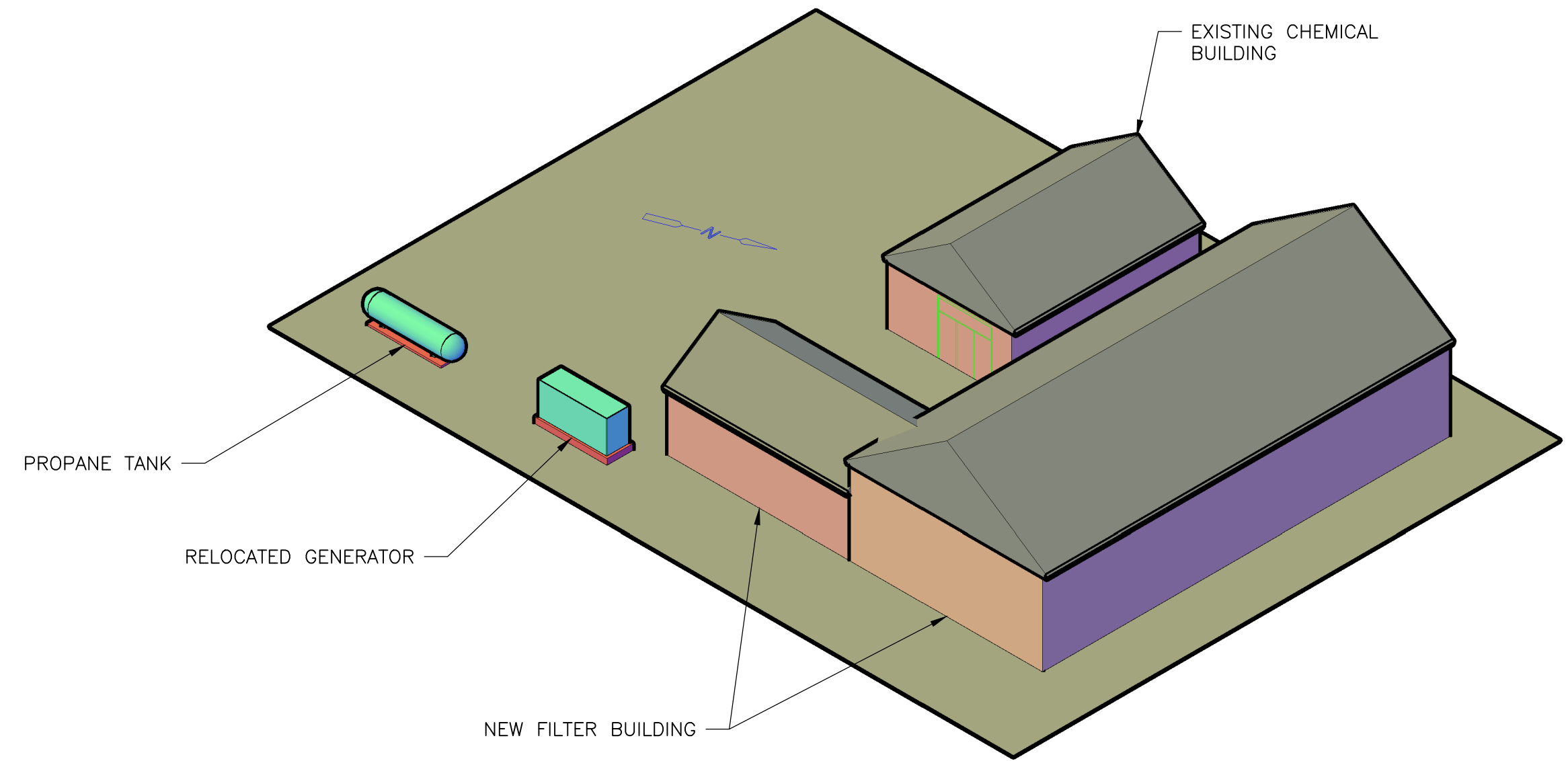
MANCHESTER-BY-THE-SEA, MASSACHUSETTS
PFAS PLANNING EVALUATION FOR LINCOLN STREET WELL

FILTER BUILDING CONCEPTUAL SITE PLAN

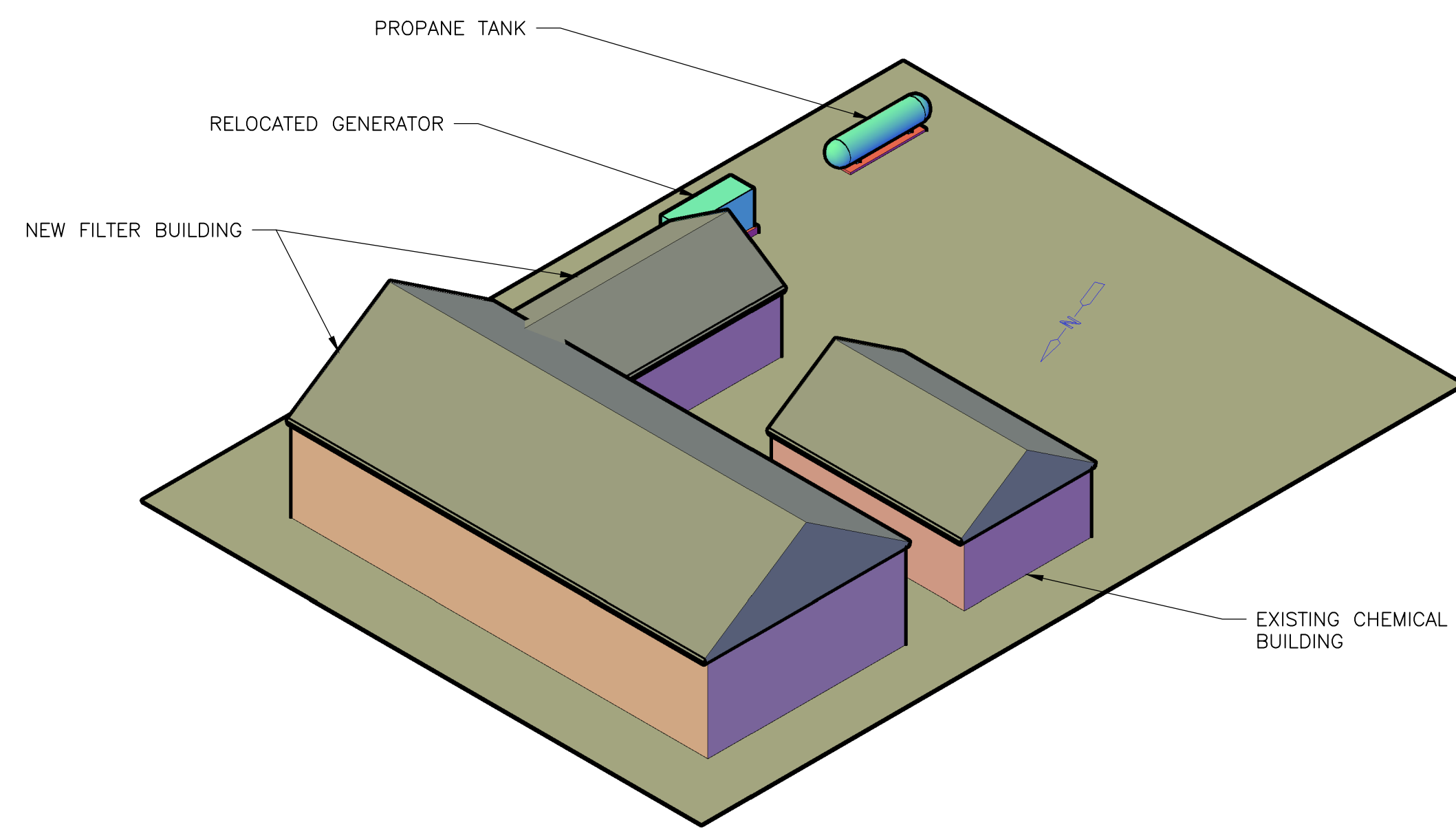
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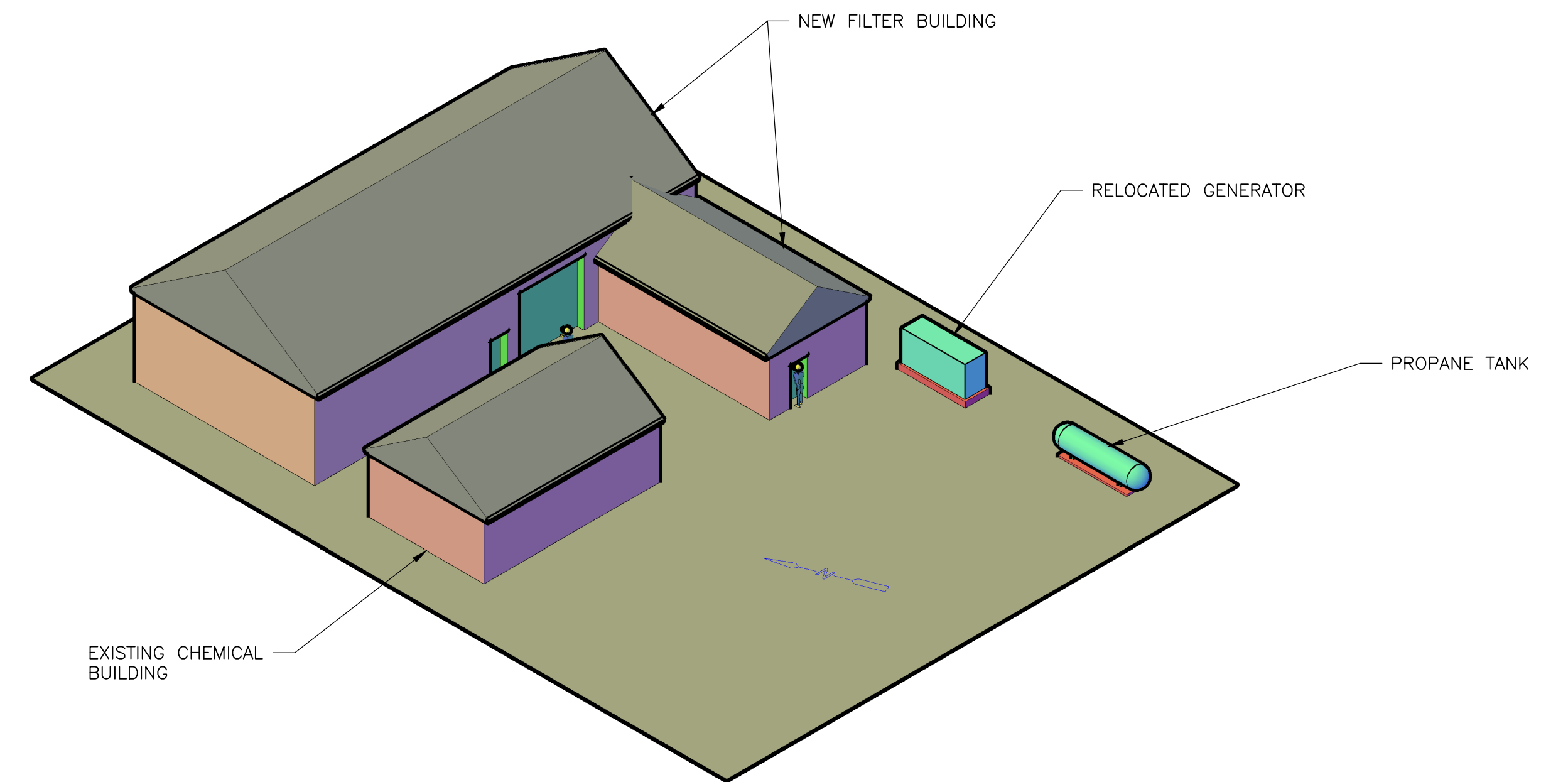
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SHEET CHK'D BY: _____	X
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APPROVED BY: _____	X
DATE: _____	JANUARY 2022

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 Manchester, NH 03101
 Tel: (603) 222-8300

MANCHESTER-BY-THE-SEA, MASSACHUSETTS
 PFAS PLANNING EVALUATION FOR
 LINCOLN STREET WELL

**FILTER BUILDING
 ISOMETRIC VIEWS**

PROJECT NO. 252299-268754
FILE NAME: xxxxxxxx
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FIGURE ES-3