Heat Impacts on Infrastructure & Personnel: A PWB Case Study

Final Report

Resilient Analytics

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Executive Summary

The Portland Water Bureau (PWB) will experience several vulnerabilities due to future increases in extreme heat events as a result of projected changes in climate. Resilient Analytics (RA) is using a climate stressor methodology to analyze the impact of such extreme temperature events on critical PWB physical infrastructure assets as well as personnel. The methodology focuses on examining the effects of extreme temperatures on personnel and facilities in the years 2030, 2050 and 2070 compared to a baseline historical period of 1990 to 2009. Note that projected costs do not account for inflation.

Increases in daily heat index and daily maximum temperatures are expected to put additional stress on outdoor workers. This could lead to additional workplace accidents resulting in additional costs for PWB.

Key findings and recommended actions for personnel:

1. By 2030, it is projected that the PWB service area will see an additional eight days of temperatures over 90°F, and one more day of temperatures over 100°F each year.
2. By 2070, it is projected that the PWB service area will see an additional 18 days of temperatures over 90°F, 4 days of temperatures over 100°F, and one day of temperature over 105°F each year.
3. The risk of PWB workplace accidents and injuries is estimated to increase by 1% to 2% by 2070 for RCP 4.5 and RCP 8.5, based on extrapolation from other heat studies
4. The number of Moderate Heat Index days (defined by OSHA) is estimated to increase from 6 days to 8 days by 2030, and to 15 days by 2070. The number of High Heat Index days (also defined by OSHA) is estimated to increase from 0.5 days to 1 day by 2030, and to 2 days by 2070.
5. PWB can continue to implement strategies to provide outdoor workers with electrolytes, ice, and cool locations for work breaks. PWB also has noted that in recent hot summers maintenance and construction crews have occasionally shifted work from typical heavy construction and trench work to hydrant repairs and main breaks – jobs that are cooler and wetter.
6. A national heat stress standard could be put into place, which would require PWB to follow a regulated work/rest cycle. Implementing a standard work/rest cycle will help to avoid additional worker accidents and health and safety impacts from increased heat.
7. To offset losses in productivity associated with increases in work/rest cycles, PWB could consider implementing scheduling related adaptation strategies to reduce exposure to mid-day heat. One example would be to flex outdoor worker schedules to earlier in the morning. Under this scenario, PWB would see savings from increased productivity. Annual savings range from $7,000 to $36,000 in 2030 and $20,000 to $164,000 in 2070 under the moderate and strict heat standard, respectively.
8. We recommend that PWB monitor extreme heat conditions over time to understand how the conditions are changing. Comparing actual conditions to the climate projections will help to understand the implications for the PWB workforce.

The facilities and assets owned and operated by PWB will also experience additional stress due to increases in temperature.

Key findings and recommended actions for assets:

1. Equipment that operates in spaces with high ambient operating temperature (spaces that are unconditioned, outdoors, have an undersized cooling system, etc.) will have shorter lifespans. Evidence of this can be seen currently at the vault pump station of Facility 4 where internal temperatures reached 110°F in the summer of 2019 according to data provided by PWB. Due to this elevated temperature, expected motor lifespan is already the lowest of any PWB facility in this study. High ambient operating temperatures are also already seen at Facilities 3 and 6. In spaces already experiencing high temperatures we recommend investigating the cost/benefit of an active cooling system or an outdoor air ventilation (fan) system to control the indoor temperature and limit equipment lifespan degradation due to high temperature operation.
2. Due to the temperature profile in Facilities 1, 2 and 5 it appears that the existing ventilation system (louvres) is helpful in mitigating extreme heat within these facilities. Even still, these facilities are some of the most susceptible to changes in outdoor air temperature which leads these facilities to have some of the highest estimated increases in motor replacements. Therefore, we recommend that indoor temperatures continue to be monitored to ensure that the cooling system is providing the necessary and expected cooling effect. If elevated temperatures continue to be seen, or temperatures appear to increase, we recommend investigating the cost/benefit of installation of additional cooling capacity. Additionally, the installation of extra cooling capacity can be evaluated now in anticipation of increasing outdoor air temperatures. Temperature monitoring will be beneficial at all pump stations to better inform temperature mitigation efforts in response to increases in outdoor air temperature. Priority should be given to facilities whose indoor temperatures are most susceptible to changes in outdoor temperature (such as facilities 1, 2, 3 and 5) so that temperature trends can be established to inform the necessity for future cooling improvements. Temperature monitoring at facilities already experiencing extreme temperatures (such as facilities 4 and 6) will also be beneficial to quantify the current magnitude of the extreme temperature problem and to evaluate the change in temperatures over time.
3. The susceptibility of an indoor facility's temperature to change in response to changing outdoor air temperature can be reduced using various building improvements. These include increased envelope insulation, tighter air sealing to prevent infiltration of outdoor air, and pre-conditioning ventilation air that is brought into the space. We recommend for PWB to evaluate the cost/benefit of retrofitting existing facilities with such features to minimize heat loads, especially those facilities that show high susceptibility to indoor temperature changes in response to outdoor temperature changes. We also recommend that PWB reviews its engineering specifications for new construction with the intent of minimizing heat gain from the outdoors.
4. In addition, to prolong motor lifespan as ambient operating temperatures increase PWB can investigate the installation of motors with higher NEMA ratings. Motors with higher NEMA ratings will cost more but can also withstand higher operating temperatures. However, motors with higher temperature ratings may also operate at higher internal temperatures, negating any increase in allowable ambient temperature[18]. When replacing or rewinding motors in the future, we recommend PWB evaluates the potential for extending the life of the motor by determining the allowable ambient operating temperature of the motor and then weighing the upfront cost

versus the cost savings from any increase in the motor lifespan due to the increased allowable ambient operating temperature.

5. We recommend that PWB monitor extreme heat conditions over time to understand how the conditions are changing. Comparing actual conditions to the climate projections will help to understand the implications for the PWB assets and system.