LLOYD eco DISTRICT

REPORT

LLOYD ECODISTRICT

CLIMATE CHANGE RESILIENCE ASSESSMENT

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EXECUTIVE SUMMARY

A preliminary climate resilience assessment has been performed for the Lloyd EcoDistrict neighborhood in Portland, Oregon considering the people and infrastructure of the district during a projected timeline over the next thirty and fifty years.

An exposure screen was first performed for the site based on current research. The screen identified projected climate hazards based on a business-as-usual emissions scenario. The most likely and impactful climate hazards for the site are expected to be:

- Increased temperature medians and extremes,
- Increased precipitation median and extremes,
- Reduced rainfall in summer leading to potential water shortage and drought,
- Reduction in snowpack and alterations to run-off periods, and
- Increased wildfire and smoke.

For each of these climate hazards a list of potential impacts and vulnerabilities to people and infrastructure was established based on best practice guidelines and case studies for an urban district such as Lloyd. Of the potential impacts assessed, the highest risks are expected to occur from:

- HVAC cooling requirements exceeding design capacity,
- Flooding of interior assets from increased precipitation,
- Extreme heat for outdoor spaces,
- Stormwater and sewer backflow from intense precipitation events,
- Poor outdoor air quality from wildfire smoke,
- Stress to plants and landscape from heat and drought,
- Electrical failure from increased cooling at peak electrical demand periods, and
- Flooding of exterior assets from increased precipitation,

The risk (likelihood and impact) of each of these vulnerabilities can be mitigated by thoughtful application of climate resilience mitigation measures. Measures impact both the design and operation phases and can be implemented as best practice across the district. The recommended mitigation measures range from creating operational plans and guidelines to address climate risk, to building design and facilities measures to protect against overheating and flood, to open space landscaping measures to promote cool areas of respite in heat waves.

EXECUTIVE SUMMARY

As these recommendations are meant to support the district in general it is acknowledged that future climate hazards will impact specific sites differently depending on building type and shape, service, occupant needs, site topology, landscaping, etc. it is recommended that site-specific climate resilience assessments be performed when possible.

1. INTRODUCTION

The following report is a preliminary climate resiliency assessment (CRA) for the Lloyd EcoDistrict (LED).

The LED is not unique in that it will be subject to global and regional climate change impacts that will have local effects on the people, buildings, infrastructure and natural assets of the district. The LED will be unique in how it will be impacted by a changing climate due to the district's orientation, topology, infrastructure, and mix of use.

The CRA outlines the climate risks that will be facing the district over the next 30 to 60 years and offers some approaches to mitigate those risks. The current study is a preliminary assessment, meant to be considered across the entire district, and to highlight potential for further, more detailed resilience assessments in the future.

2. OVERVIEW OF METHODOLOGY

Boundaries: The study area includes the entire area of the Lloyd EcoDistrict. The LED is bounded by the Willamette River to the Broadway Bridge to the west, NE Broadway to the north, NE 17th to the east, and the I84 to the south.

LED Boundary (yellow polygon) outlines Extents of Climate Resilience Assessment

The district has many diverse physical assets from public spaces to community organizations to economic infrastructure. In general, the district is a fully developed urban properties, primarily covered in buildings and hardscape, with a small amount of green space.

Timescale: The timescale for the climate resilience assessment considers two future timeframes looking out to 2050 and 2080.

Climate scenarios: The International Panel on Climate Change (IPCC) has established four GHG emissions scenarios based on representative concentration pathways (RCPs). The RCP 8.5 pathway is the global 'business as usual' greenhouse gas emission scenario and is widely considered a best practice for use in climate resilience assessments and will be used primarily in this study.

Review of available climate projections: The climate exposure screen is based on the current literature available for climate projections in the region. The primary source of information referenced is the Fifth Oregon Climate Assessment issued by the Oregon Climate Change Research Institute in January 2021.

Risk Assessment: The district vulnerabilities have been identified based on an understanding of the assets and use of the district provided by the LED team as well as available general resiliency guidelines and consultant experience. The preliminary CRA will provide an initial overview of climate vulnerabilities and potential mitigation solutions to be considered by stakeholders of the LED. A detailed CRA that looks at individual sites and considers stakeholder input on vulnerabilities would offer further granularity and further climate security. Risk assessments should be considered as an ongoing process and it is therefore recommended that to revisit the vulnerability and risk assessments and the control measures considered in this resilience assessment as new information becomes available (e.g., updated climate projections, changes to operating parameters and/or local conditions) during detailed design of individual projects and at a minimum of every 5 years during operation.

3. CLIMATE EXPOSURE SCREEN

To determine the specific climate impacts that the district can expect over the next 30 to 60 years a climate exposure screen was performed. The exposure screen is a review of existing climate change projection literature for the region highlighting the most likely and impactful climate outcomes for the district.

The climate risk assessment identified the site-specific climate hazards for the project to be:

- Increased temperature medians and extremes,
- Increased precipitation median and extremes,
- Reduced rainfall in summer leading to potential water shortage and drought,
- Reduction in snowpack and alterations to run-off periods, and
- Increased wildfire and smoke.

Additional regional climate hazards that are not likely to impact the site include:

- Coastal hazards – sea level rise and increased storminess
- Wind, ice/frost, fog, snow accumulation

The following section will provide a brief overview and summary of the relevant future climate information assessed for the exposure screen and presented in the climate hazard workshop.

3.1 Increased Temperature Median and Extremes

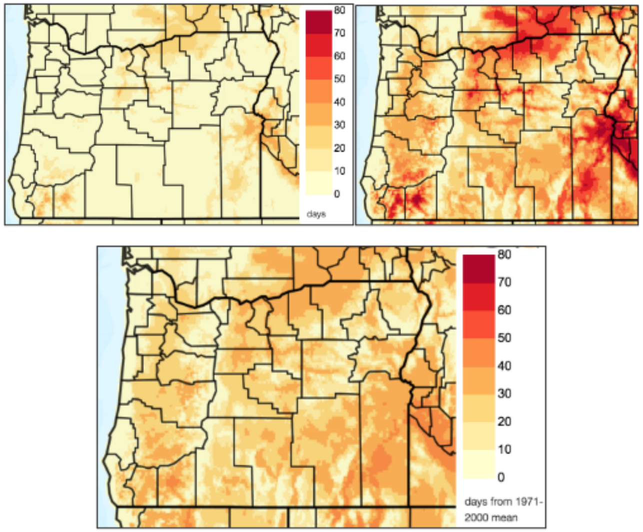
Past climatic conditions were compared to climate variables for the 2050s and 2080s based on the business-as-usual representative concentration pathway (RCP8.5) scenario. Projections indicate that future dry bulb temperatures, both mean and peak, are expected to rise through the coming decades.

	2050s		2080s	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Annual	3.6 (1.8, 5.4)	5.0 (2.9, 6.9)	4.6 (2.1, 6.7)	8.2 (4.8, 10.7)
Winter	3.3 (1.6, 5.1)	4.5 (2.4, 6.5)	4.2 (1.8, 6.5)	7.4 (4.2, 9.8)
Spring	3.1 (1.4, 5.0)	4.1 (2.0, 5.9)	3.8 (1.7, 6.0)	6.7 (3.8, 9.2)
Summer	4.5 (2.2, 6.8)	6.3 (3.6, 8.9)	5.5 (2.7, 8.3)	10.2 (6.5, 13.9)
Autumn	3.7 (1.5, 5.4)	5.2 (2.6, 7.0)	4.7 (2.0, 6.9)	8.6 (4.6, 11.4)

Projected Mean Annual and Seasonal Temperature (°F) in Oregon from the historical baseline[1]

On average for Oregon the annual mean temperature for and RCP8.5 scenario is expected to rise 5.0°F by 2050 and by 8.2°F by 2080. There is projected to be a higher increase in summer months.

Higher mean temperatures will also translate to longer periods of extreme heat. In Multnomah County, the number of days with a heat index greater than 90°F are projected to increase from 4 (historically from 1971-2000) to 23 by mid-twenty-first century (2040-2069).



Number of days from April through October with a heat index >90°F in historic and future periods[2]

[1] Fifth Oregon Climate Assessment, Oregon Climate Change Research Institute, January 2021

[2] Dahl, K., R. Licker, J.T. Abatzoglou, and J. Declet-Barreto. 2019. Increased frequency of and population exposure to extreme heat index days in the United States during the 21st century. Environmental Research Communications

County	Historical baseline (1971–2000)	Mid-twenty-first century RCP 8.5 (2040–2069)	Change	County	Historical baseline (1971–2000)	Mid-twenty-first century RCP 8.5 (2040–2069)	Change
Baker	5	27	22	Lake	3	24	21
Benton	4	25	21	Lane	4	24	20
Clackamas	2	15	13	Lincoln	1	6	5
Clatsop	1	6	5	Linn	3	22	19
Columbia	2	16	14	Malheur	12	45	33
Coos	1	7	6	Marion	3	20	17
Crook	4	26	22	Morrow	12	38	26
Curry	3	15	12	Multnomah	4	23	20
Deschutes	3	21	18	Polk	4	23	19
Douglas	6	28	22	Sherman	13	42	29
Gilliam	14	43	29	Tillamook	0	4	4
Grant	3	21	18	Umatilla	10	35	24
Harney	4	30	26	Union	3	20	17
Hood River	2	12	10	Wallowa	4	21	18
Jackson	9	33	24	Wasco	9	34	24
Jefferson	9	33	24	Washington	4	21	17
Josephine	13	40	26	Wheeler	7	28	22
Klamath	2	20	17	Yamhill	5	24	19

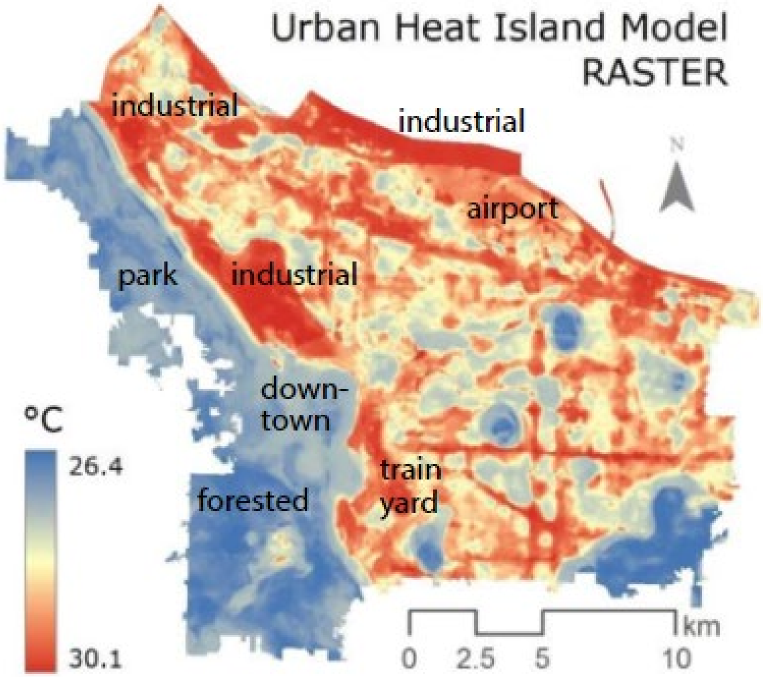
Average values of changes in the number of days from April through October with a heat index >90°F in historical and future periods under RCP8.5[3]

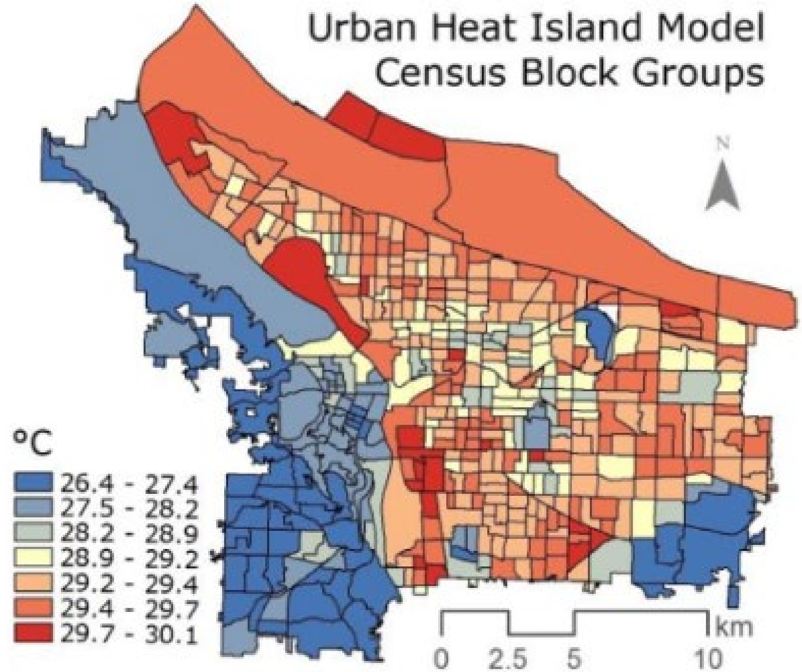
To exacerbate this projected heating trend, Portland is noted as having one of the most intense heat island effects in the US as defined by the average difference between the temperatures of a city and its rural surroundings[4]. The most impacted areas of Portland include interstate corridors and industrial zones. As can be seen in the measurements taken by Voelkel et al[5] temperatures can vary by over 7°F from forested to industrial areas across Portland on a hot day. Lloyd district is one of the areas most impacted by urban heat island effect across the city.

[3] Dahl, K., R. Licker, J.T. Abatzoglou, and J. Declet-Barreto. 2019. Increased frequency of and population exposure to extreme heat index days in the United States during the 21st century. Environmental Research Communications

[4] Fifth Oregon Climate Assessment, Oregon Climate Change Research Institute, January 2021

[5] Voelkel, J., D. Hellman, R. Sakuma, and V. Shandas. 2018. Assessing vulnerability to urban heat: a study of disproportionate heat exposure and access to refuge by socio-demographic status in Portland, Oregon. International Journal of Environmental Research and Public Health 15:640. DOI: 10.3390/ijerph15040640.



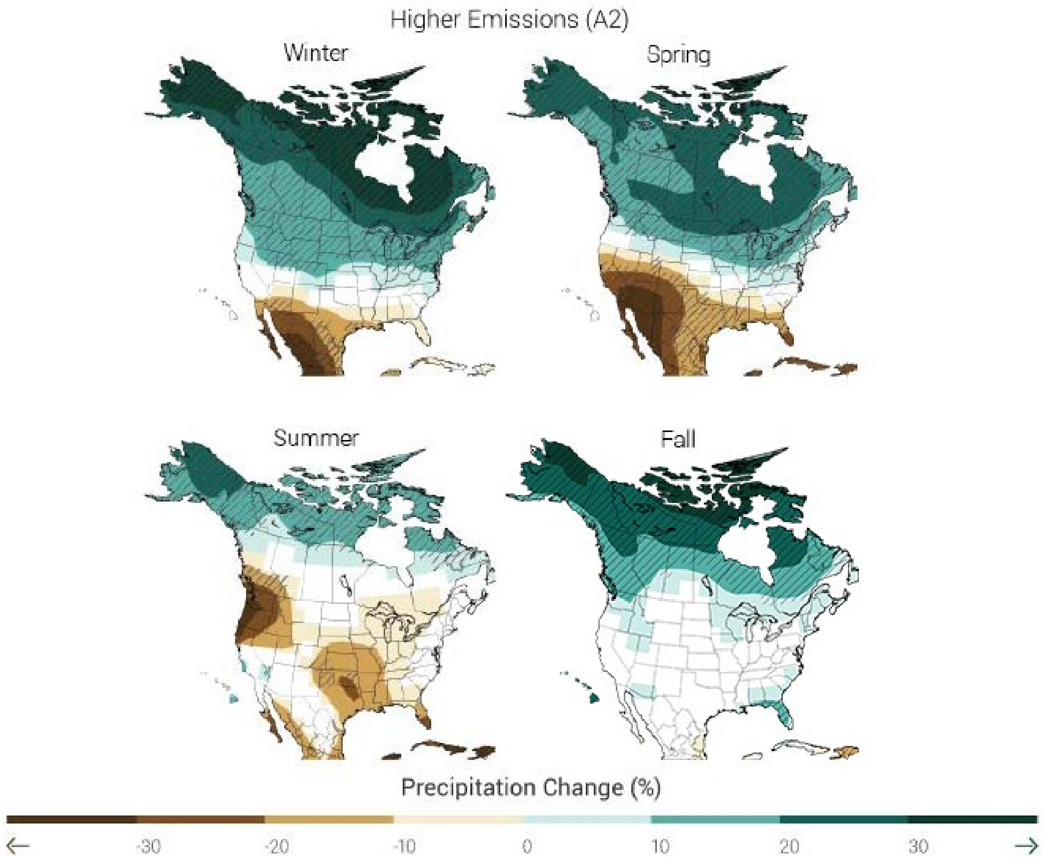


Urban heat island effects as measured (left) and defined by census block (right) in Portland

[6] Voelkel, J., D. Hellman, R. Sakuma, and V. Shandas. 2018. Assessing vulnerability to urban heat: a study of disproportionate heat exposure and access to refuge by socio-demographic status in Portland, Oregon. International Journal of Environmental Research and Public Health 15:640. DOI: 10.3390/ijerph15040640.

3.2 Increased Precipitation Median and Extremes

Modeled future climate predictions for Oregon estimate that the total annual precipitation is predicted to increase, as is the number of heavy precipitation days and maximum 1-day precipitation events.



Projected Precipitation Change by Season for future climate (2071-2099) compared to historic baseline (1970-1999)[7]

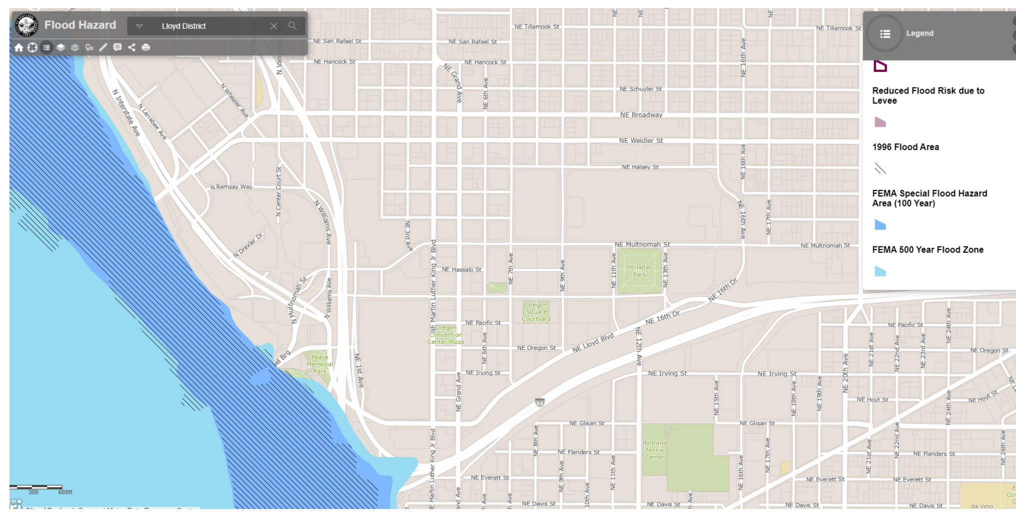
[7] National Climate Assessment, U.S. Global Change Research Program, 2014. Accessed at: https://nca2014.globalchange.gov/highlights/report-findings/future-climate

The average annual precipitation shows a substantial projected increase in the winter (7.9% from historical baseline in 2050, 14.5% by 2080), including more winter precipitation falling as rain instead of snow, in contrast with an anticipated decrease in seasonal precipitation during the summer (-4.6% from historical baseline in 2050, -7.7% by 2080). The anticipated increase in annual precipitation is expected to occur in short periods, resulting in more extreme, intense, and frequent precipitation events. The number of days with atmospheric rivers present across Oregon projected to increase by roughly 5-10% over western Oregon by the 2080 timeframe[8].

	2050s		2080s	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Annual	1.9 (-4.9, 9.0)	2.7 (-6.0, 11.4)	3.4 (-5.6, 15.3)	6.3 (-5.2, 19.9)
Winter	4.9 (-6.4, 16.5)	7.9 (-4.7, 24.3)	7.3 (-6.3, 19.9)	14.5 (-2.8, 37.1)
Spring	1.9 (-8.9,12.1)	2.7 (-7.2, 17.4)	3.4 (-7.7, 14.9)	3.6 (-9.4, 15.6)
Summer	-6.3 (-28.5, 16.1)	-8.7 (-33.1, 22.5)	-4.6 (-24.2, 22.3)	-7.7 (-38.7, 33.5)
Autumn	0.5 (-17.0, 14.4)	-0.8 (-17.1, 14.9)	1.5 (-15.0, 18.1)	1.9 (-17.2, 24.2)

Projected future relative changes in total annual and seasonal precipitation (%) in Oregon from the historical baseline (1970-1999)[9]

Increased rainfall intensity in Portland can lead to increased flood risk from pluvial (heavy rainfall-related flooding) and/or fluvial (river) flooding. The first will pose a risk to the Lloyd District, but due to its elevated location, riverine flooding will be limited to directly adjacent to the Willamette shores of the district. This can be seen in the 100- and 500-year flood plains shown in the FEMA flood map for the site .



Flood Map for Lloyd EcoDistrict showing100 and 500-year flood hazard areas[10]

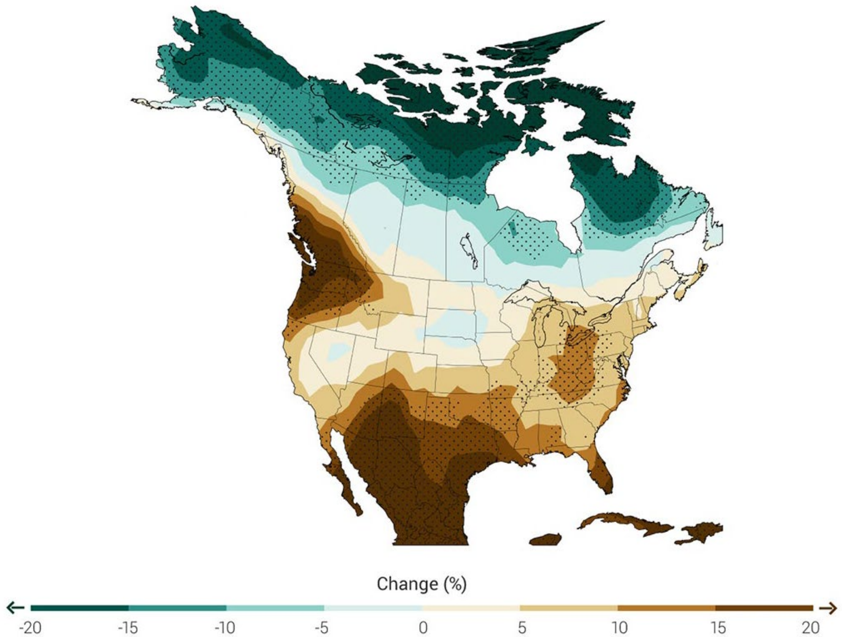
[9] Fifth Oregon Climate Assessment, Oregon Climate Change Research Institute, January 2021

[10] FEMA Flood Map, https://pdx.maps.arcgis.com/home/item.html?id=f23b1f78bcd846e7b83769ad0638da0f

3.3 Reduced Precipitation in Summer Months

As shown in the previous section, the mean summer precipitation is expected to decrease across Oregon by nearly 8% by 2080 compared to a historic baseline. The National Climate Assessment shows that the Portland is within one of the regions in North America expected to see the biggest changes (15+%) in dry days (RCP8.5 for 2080 timeframe).

Precipitation that falls during winter months is generally sequestered as snowpack at higher elevations, which eventually melts and is distributed to aquifers and local streams. However, as discussed in the previous section, predicted temperature increases are expected, which are predicted to reduce snowpack dramatically as more winter precipitation falls as rain instead of snow. These conditions are projected to increase winter runoff and decrease runoff during spring and summer[11] leading to increased periods of regional drought.



Projected Change in Maximum Number of Consecutive Dry Days for future climate (2071-2099) compared to historic baseline (1970-1999)[12]

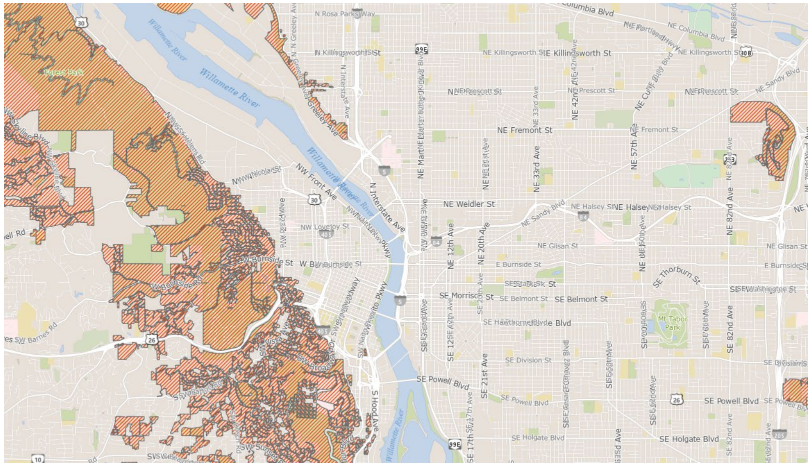
[11] Fifth Oregon Climate Assessment, Oregon Climate Change Research Institute, January 2021

[12] National Climate Assessment, U.S. Global Change Research Program, 2014. Accessed at: https://nca2014.globalchange.gov/highlights/report-findings/future-climate

3.4 Wildfire Smoke

The temperature and precipitation forecasts described above indicate a likelihood of longer periods of dry weather and anticipated drought conditions for summers in the 2050 and 2080 timeframe. The drier summer conditions, as a result of decreasing precipitation and decreased snowpack, are expected to lead to increased risk of regional wildfire activity. Climate change will be the main driver of wildfires and will contribute to increasing poor air quality from both regional fires and increasing fires throughout North America.

The wildfire hazard zones produced by the City of Portland show that the Lloyd District is not in an area of direct risk from wildfire[13]. Regionally, the number of wildfire occurrences (number of fires) is on the rise as well as an increase in very-large fires (top 10 to 15%)[14].



City of Portland Wildfire Hazard Zones (orange)[13]

The main risk to the Lloyd District from wildfire will be the poor air quality as a result of nearby or regional fires. Research has shown that that particulate matter concentrations will increase significantly because of increased fire activity across North America[15]. High levels of particulate matter in the air cause adverse health impacts and respiratory issues as well as being a known carcinogen.

[13] City of Portland, Wildfire Hazard Zones, Accessed at: https://pdx.maps.arcgis.com/home/item.html?id=13fd342109544ec48d665b8e0891bc41

[14] Fifth Oregon Climate Assessment, Oregon Climate Change Research Institute, January 2021

[15] Pierce JR, Val Martin M, Heald CL. 2017. Estimating the Effects of Changing Climate on Fires and Consequences for U.S. Air Quality. Joint Fire Science Project 13-1-01-4. Ft. Collins, CO: Colorado State University. 29 p.

A climate resilience assessment is meant to highlight potential impacts from identified climate hazards and the associated vulnerabilities that they pose to people, assets, and infrastructure. For a full climate resilience assessment, it is recommended that individual sites be considered independently with relevant stakeholders providing input on the potential vulnerabilities that would be specific to the people, assets, infrastructure and services of that site. As this is a preliminary assessment, meant to provide general guidance to the entire district the impacts and vulnerabilities highlighted in this section are based on guides, best practices, and project experience for urban districts.

The potential impacts and climate vulnerabilities specific to the Lloyd EcoDistrict are listed in the following table, organized by the identified climate hazards of significance.

Summary of Potential Climate Risk-Induced Impact Scenarios

Climate Hazard	Potential Impact	Climate Vulnerability
Increased Temperature (Extreme Heat & Drought)	**1. HVAC cooling requirements in buildings exceeding design capacity**	**People:** • Increased thermal discomfort, agitation, and mental health stress, leading to potential increased in missed workdays. • Increase risk of heat stroke. • Increase number of hospitals visits due to respiratory problems. • Increased risk to health of vulnerable populations, • Low humidity rates, increased virus transfer. **Asset: & Infrastructure:** • Increased cost of HVAC equipment (capital and operational). • Increased use and wear on HVAC equipment. • Additional dehumidification requirements. risk to IT systems. • Portable AC units adding demand to electrical system. • Increased period of cooling (less down time for chillers/maintenance). Limits to ability to expand HVAC over time.

Climate Hazard	Potential Impact	Climate Vulnerability
Increased Temperature (Extreme Heat & Drought)	**2. Stress to outdoor plants and landscape**	**People:** • Walking paths / gardens negatively impacted by plant health. • Loss of use/enjoyment of outdoor space (recreation, connection to outdoors). **Asset: & Infrastructure:** • Risk of landscape health. • Additional water resources for irrigation. • Poor plant health leading to increased windfall. Mature trees more susceptible. • Grass areas when dry have potential for fires. • Increased levels of dust impacting air quality. • Increase in pest/infestation.
	3. Extreme heat in outdoor spaces	**People:** • Increased thermal discomfort, agitation, and mental health stress. • Increase risk of heat stroke and respiratory problems. • Increased risk to health of vulnerable populations. • If persistent, may result in odor and insects from garbage. **Asset & Infrastructure:** • Intensified by urban heat island effect. • Thermal damage of exposed materials.

Climate Hazard	Potential Impact	Climate Vulnerability
Increased Temperature (Extreme Heat & Drought)	**4. Increased cooling at peak electrical demand periods leading to overload of electrical systems**	**People:** • Risk of discomfort leading to heat stress if backup systems fail / undersized. **Asset: & Infrastructure:** • Increased reliance on back-up power systems. • Power and load shedding procedures (prioritize vital spaces). Risk of running out of generator capacity.
	5. Increased degradation of building components and materials	**Asset & Infrastructure:** • Exposure of envelope and building components could result in reduced service life. • Increased replacement costs. • Sun exposure on rooftop equipment (more regular maintenance/painting). • Building sealants (more frequent maintenance). • Thermal expansion of material leading to failure.

Climate Hazard	Potential Impact	Climate Vulnerability
Precipitation	**6. Increased precipitation leading to flooding of building interiors via moisture ingress**	**People:** • Risk loss of functionality and use of spaces. • Potential water ingress leading to mold. infection and other negative health impacts. • Losses and damages increase mental health stress. **Asset & Infrastructure:** • Water damage to façade and interior assets. • Reduction in water quality. • Loss of equipment use and potential damage when relocating. • Water shedding capabilities of roofs and drainage outfalls. • Risk of drainage that relies on pumps (redundancy/failure prevention). • Risk of wind driven rain ingress.
	7. Increased precipitation leading to flooding of exterior spaces	**People:** • Loss of accessibility. • Increased risk of waterborne diseases. **Asset & Infrastructure:** • Water damage to exterior infrastructure, landscaping, etc. • Access issues for community, below-grade parking etc. most vulnerable

Climate Hazard	Potential Impact	Climate Vulnerability
Precipitation	**8. Potential of stormwater and sewer backflow from intense precipitation events**	**People:** • Risk of loss of functionality and continuity of services. • Potential water ingress and mold leading to negative health impacts. • Losses and damages increase mental health stress. **Asset & Infrastructure:** • Water damage to interior assets, reduction in water quality.
	9. Increased precipitation leading to waterlogged soil and potential instability	**People:** • Risk of personal safety and security. • Slip and fall issues on grass (off path). • Risk of loss of accessibility and continuity of services. **Asset & Infrastructure:** • Risk of erosion. • Landslide causing damage to infrastructure.

Climate Hazard	Potential Impact	Climate Vulnerability
Wildfire Smoke	**10. Poor outdoor air quality from regional wildfire smoke**	**People:** • Poor AQ increase health effects, particularly for vulnerable populations (pre-existing conditions, pregnant women, infants, elderly). • Increased missed workdays. • Odor issues/complaints. • Limited visibility. • Combined impacts w/ heat (can't open windows for cooling). **Asset & Infrastructure:** • Increased levels of fine particulate matter (PM) require additional filter maintenance and fan energy. • Lack of space available for filtration equipment (no additional rack capacity).

Of the ten (10) potential impacts assessed, the eight (8) highest risks are likely to occur from:

- HVAC cooling requirements exceeding design capacity,
- Flooding of interior assets from increased precipitation,
- Extreme heat for outdoor spaces,
- Stormwater and sewer backflow from intense precipitation events,
- Poor outdoor air quality from wildfire smoke,
- Stress to plants and landscape from heat and drought,
- Electrical failure from increased cooling at peak electrical demand periods, and
- Flooding of exterior assets from increased precipitation,

While there are many consequences that could occur from each impact, the below section focuses on the priority consequences that mandate controls. Less consequential impacts that do not warrant controls are not discussed.

5 RESILIENT DESIGN MEASURES

In the previous section, a risk assessment was performed on the consequence of climate change hazards on the district assets. The impacts with the highest risk (greater likelihood of occurring and/or greater consequences) are overheating, flooding, stormwater backflow, and poor outdoor air quality from wildfire smoke. For these impacts it is recommended that some controls be implemented to mitigate the level of risk to the people and infrastructure of the LED.

The following section outlines potential adaptation measures that may be incorporated in future design, retrofits, and operational planning to reduce each of these climate risks and vulnerabilities to acceptable levels.

5.1 HVAC Cooling Requirements Exceeding Design Capacity

To mitigate the risk of overheating as a result of increased outdoor air temperatures and summer peaks, the following measures will be considered for implementation in the design:

- Size cooling equipment to meet 2050 design criteria (making design allowances for a staged approach towards 2080 with the base design to be 20% oversized over 2050),
- Provide additional space in mechanical rooms to consider need for additional future cooling,
- Reduce cooling loads through high-performance envelope design including air tightness,
- Prioritize critical spaces for space conditioning over others (e.g., temp and humidity levels are critical),
- Design for passive cooling (e.g., consider solar shading (structures, landscape), natural ventilation, geo-exchange, thermal mass w/ night flush), and
- Relax interior setpoint temperatures during peak cooling periods (non-sensitive locations).

The numerous passive mitigation measures for passive cooling load reduction are expected to potentially offset the increase in cooling design criteria and over-sizing of mechanical cooling systems to meet 2050 design criteria. The passive design measures will have the co-benefit of reducing energy consumption and costs and mitigate carbon generation required of grid power.

5.2 Flooding of Interior Assets from Increased Precipitation

The topology of the district, with slope towards the Willamette and to the south, will continue to provide good natural stormwater drainage generally away from the built infrastructure. In addition, to mitigate the risk of interior flooding from increased precipitation the following measures will be considered and implemented in the design:

- Locate critical equipment outside of high-risk flood areas (i.e., basements) with 500-yr flood plain elevation considered,
- Design storm and roof drainage to consider increased rainfall volumes due to climate change
- Protect below-grade exterior foundation walls from moisture ingress,
- Keep flood mitigation supplies (spill kits/scrubbers) on hand to use in the event of a flood,
- Where necessary, select higher performance, water-resistant building materials to reduce damage to building structure, envelope, and interior finishes,
- Where necessary, select mold-resistant materials, and
- Backup potable water supply in case of water quality degradation during flood event.

By aggressively restricting and monitoring for water ingress, the co-benefit will be a dry interior, reducing the risk of mold growth and the associated negative respiratory impacts.

5.3 Extreme Heat for Outdoor Spaces

To mitigate the risk of extreme temperature peaks and durations in outdoor spaces the following measures should be considered:

- Provide shaded external spaces with access to power and water services.
- Outdoor cooling station that can run on emergency power
- Reduce heat island impacts by increasing soft landscaping (green) and reduce hardscape coverage
- Increasing vegetation to provide natural cooling via shade and evapotranspiration,
- Reduce heat island impacts by selecting light-colored, reflective materials,
- Reduce (combustion engine) vehicle traffic during prolonged periods of heat to reduce heat gains and improve air quality
- Encourage natural ventilation of outdoor spaces by allowing predominant summer winds to pass through open outdoor spaces.
- Drought-resistant landscape decisions (i.e., drought-tolerant native plant selection, drip irrigation)

The co-benefits of comfortable outdoor spaces with increased natural vegetation will be improved connection to nature and subsequent well-being benefits for occupants as well as increased natural habitats.

5.4 Stormwater and Sewer Backflow from Intense Precipitation Events

To mitigate the risk of stormwater and sewer backflow from increasing intensity of precipitation events the following measures should be considered:

- Maintain stormwater drainage systems to ensure proper functionality (i.e., clean gutters and downspouts, inspect drains)
- Backflow prevention devices as part of storm drainage design,
- Low impact development (LID) practices with landscape grading and berms for exposed areas,
- Landscape design to integrate low impact design strategies, such as rain gardens, bioswales, and permeable pavement, and
- Protocol to test for potable water quality in event of stormwater backflow events.
- Ensure equipment and devices follow FEMA 55 guidelines and FEMA technical bulletins and advisories for wet and dry flood-proofing.

By considering and restricting potential water ingress, the co-benefit will be a dry interior, reducing the risk of mold growth and the associated negative respiratory impacts.

5.5 Poor Outdoor Air Quality from Wildfire Smoke

To mitigate the risk of poor indoor air quality as a result of high particulate matter (PM) levels in the outdoor air from regional wildfire smoke the following measures should be considered:

- MERV (minimum efficiency reporting values) 13 filtration on all outdoor air (OA),
- Consider additional rack for added filtration (MERV 14, carbon),
- In-room HEPA filter (portable) for critical spaces,
- Operation strategies to limit air infiltration (door operation protocols),
- On-site monitoring of PM2.5 levels and coordinating with the building management system (control operable, ventilation). Communicate to facilities teams and occupants,
- Fire smart landscape design can also mitigate localized / site specific fire risk,
- Keyed operable windows,
- Secondary ducting or filtering system for emergency (poor AQ) scenarios,
- 100% recirculation mode for HVAC, and
- Vestibules on main entrances (limit smoke infiltration).

The co-benefit of these measures will be cleaner air to breath and reduced viral risk year-round for occupants of the buildings.

5.6 Stress to Plants and Landscape from Heat & Drought

To mitigate the risk to plants and landscape of drought stress from increased hot and dry periods in future summers the following measures should be considered:

- Select planting based on drought resistance (Plant selection will focus on native / adapted plants that are resilient and appropriate to the local context),
- High efficiency drip, utilizing stormwater (below the soil, no access or risk to human health, and reduced evaporation),
- Onsite cisterns for water storage (complete with testing for water quality), and
- Rainwater capture (rooftop).

The co-benefit of drought-resistant plantings and high-efficiency irrigation is reduced water use for irrigation. As well, native plantings will attract native bug and bird species promoting native biodiversity at the site.

5.7 Electrical Failure from Increased Cooling at Peak Electrical Demand Periods

To mitigate the risk of increased cooling energy requirements leading to peak electrical demands exceeding capacities of electrical / refrigeration systems the following measures should be considered:

- Prioritizing critical areas for backup power,
- Uninterrupted power system (UPS) for critical systems (fire alarm panel, lighting, IT equipment),
- Additional portable power supply (for critical and emergency equipment),
- Uninterrupted back up power for entire site,
- Increase backup power supply to cover longer durations,
- On-site renewable power production (peak shave, non-essential loads), and
- Battery storage on site as a buffer.

In conjunction with reducing cooling demand through passive design measures and increased cooling capacity, the back-up power measures outlined here will protect the critical systems from power loss during peak electrical demand scenarios. The co-benefit of back-up power systems is to ensure power autonomy during other emergency events, such as earthquakes, providing the site with a more resilient power system.

5.8 Flooding of Exterior Assets from Increased Precipitation

To mitigate the risk of exterior flooding from increased precipitation the following measures should be considered:

- Design site stormwater conveyance away from structures for increased volumes and flows,
- Slope lower level towards a dedicated location to allow for pumping of flood water,
- Maximize site permeability, including open-grid pavement systems,
- Sump pumps at lowest point of construction (e.g., below grade parking, elevator pits),
- Incorporate landscape features such bioswales with native plants to absorb and redirect water on-site,
- Sump pumps and alarms on emergency power,
- Consider flood risk when locating critical infrastructure outside of building, and
- Overflow water areas such as plazas designed as reservoirs and constructed wetlands (risk: mosquitoes).

Along with the specific recommendations the following general measures are recommended best practice:

- Prepare emergency communication plan to address climate event,
- Provide training and support networks for climate events – resilient people and social organizations are key to successfully engaging the resilience challenge.
- Establish a resiliency management system and Resilience Plan

6 SUMMARY

A preliminary climate change resilience assessment has been performed for the Lloyd EcoDistrict to serve as general guidance for owners, designers, facility managers, occupants, and service providers on how to reduce the local impacts of climate change. The study considered the future climate scenarios for the years 2050 and 2080 following a business-as-usual (RCP8.5) greenhouse gas emissions scenario. The assessment considered the urban setting of the district in general, considering buildings, people, and assets but did not consider specifics sites or the detailed structures or services of each.

The first component of this assessment involved investigating future climate hazard exposure, which revealed priority climate threats as being: increases in temperature, increases in precipitation, increased heat wave and drought, and increased wildfire impacts. These are summarized in Section 3 “Climate Exposure Screen”.

A preliminary climate risk assessment was performed with respect to climate change events impact on general district assets and operations. These findings are summarized in Section 4 “Climate Resilience Assessment”. The potential impact and vulnerabilities for each climate hazard have been identified, including (in general) overheating, flooding, stormwater backflow, wildfire smoke, drought, and peak electricity demands.

Measures to mitigate against these unwanted consequences and further improve the district’s climate resilience were then explored. Section 5 “Resilient Design Measures” proposes a list of measures to mitigate the future climate hazards and vulnerabilities at the site. Measures included design and operational considerations.

The recommendations made in this assessment are meant to support the district in general as it is acknowledged that future climate hazards will impact specific sites differently depending on building type and shape, service, occupant needs, site topology, landscaping, etc. it is recommended that site-specific climate resilience assessments be performed when possible.

As well, risk assessments should be considered as an ongoing process and it is therefore recommended that to revisit the vulnerability and risk assessments and the control measures considered in this resilience assessment as new information becomes available (e.g., updated climate projections, changes to operating parameters and/or local conditions) during detailed design and at a minimum of every 5 years during operation.