Minto-Brown Island Park Boardwalk

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UNIVERSITY OF OREGON
Portland State University
CITY OF Salem AT YOUR SERVICE
SCI Sustainable Cities Institute
SCYP Sustainable City Year Program

About SCI

The Sustainable Cities Institute (SCI) is an applied think tank focusing on sustainability and cities through applied research, teaching, and community partnerships. We work across disciplines that match the complexity of cities to address sustainability challenges, from regional planning to building design and from enhancing engagement of diverse communities to understanding the impacts on municipal budgets from disruptive technologies and many issues in between.

SCI focuses on sustainability-based research and teaching opportunities through two primary efforts:

1. Our Sustainable City Year Program (SCYP), a massively scaled university-community partnership program that matches the resources of the University with one Oregon community each year to help advance that community's sustainability goals; and

2. Our Urbanism Next Center, which focuses on how autonomous vehicles, e-commerce, and the sharing economy will impact the form and function of cities.

In all cases, we share our expertise and experiences with scholars, policymakers, community leaders, and project partners. We further extend our impact via an annual Expert-in-Residence Program, SCI China visiting scholars program, study abroad course on redesigning cities for people on bicycle, and through our co-leadership of the Educational Partnerships for Innovation in Communities Network (EPIC-N), which is transferring SCYP to universities and communities across the globe. Our work connects student passion, faculty experience, and community needs to produce innovative, tangible solutions for the creation of a sustainable society.

About SCYP

The Sustainable City Year Program (SCYP) is a yearlong partnership between SCI and a partner in Oregon, in which students and faculty in courses from across the university collaborate with a public entity on sustainability and livability projects. SCYP faculty and students work in collaboration with staff from the partner agency through a variety of studio projects and service- learning courses to provide students with real-world projects to investigate. Students bring energy, enthusiasm, and innovative approaches to difficult, persistent problems. SCYP's primary value derives from collaborations that result in on-the-ground impact and expanded conversations for a community ready to transition to a more sustainable and livable future.

About City of Salem

The City of Salem is Oregon's second largest city (182,396; 2022) and the State's capital. A diverse community, Salem has well-established neighborhoods, a family-friendly ambiance, and a small town feel, with easy access to the Willamette riverfront and nearby outdoor recreation, and a variety of cultural opportunities.

FIG. 1

Riverfront Park

Image Courtesy: Ron Cooper

The City is known for having one of Oregon's healthiest historic downtowns, hosts an airport with passenger air service, and is centrally located in the heart of the Willamette Valley, 47 miles south of Portland and an hour from the Cascade Mountains to the east and the ocean beaches to the west.

State government is Salem's largest employer, followed by the Salem-Keizer School District and Salem Health. The City also serves as a hub for area farming communities and is a major agricultural food processing center. A plethora of higher education institutions are located in Salem, ranging from public Western Oregon University, private Willamette and Corban universities, and Chemeketa Community College.

Salem is in the midst of sustained, steady growth. As a "full-service" city, it provides residents with services such as police and fire protection, emergency services, sewage collection and treatment, garbage collection, and safe drinking water. Salem also provides planning and permitting to help manage growth, as well as economic development to support job creation and downtown development. The City also provides 2,338 acres of parks, libraries and educational programs, housing and social services, public spaces, streetscaping, and public art.

Salem's vision is a safe, livable, and sustainable capital city, with a thriving economy and a vibrant community that is welcoming to all. The City's mission is to provide fiscally sustainable and quality services to enrich the lives of present and future residents, protect and enhance the quality of the environment and neighborhoods, and support the vitality of the economy. The City is in the midst of a variety of planning efforts that will shape its future, ranging from climate action planning and implementation, a transportation system plan update, as well as parks master planning.

This SCYP and City of Salem partnership is possible in part due to support from U.S. Senators Ron Wyden and Jeff Merkley, as well as former Congressman Peter DeFazio, who secured federal funding for SCYP through Congressionally Directed Spending. With additional funding from the city, the partnership will allow UO students and faculty to study and make recommendations on city-identified projects and issues.

Course Participants & Description

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PSU Civil & Environment Engineering Project (PSU CE 484) is a capstone course covering engineering design processes, including owner design, professional-constructor relationships, procurement procedures, project evolution; contracts, dispute resolution, bonds, warranties; construction documents, including specifications; cost estimating, planning, and scheduling; construction administration; group process, diversity, and leadership.

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We would like to thank Robert Romanek and Aaron Kimsey from the City of Salem for their guidance and insight into the Minto-Brown Island Park Project. We would also like to thank Patrick McLaughlin and Mary Ann Triska for their support and guidance throughout the design process. Thanks to the Portland State University Geotechnical Research Laboratory for the use of equipment and materials for soil sampling, and Kayla Sorenson in particular, for guidance on settlement of silty soils. Also, thanks to Kurtis Pipkin, from Harper Hoff Peterson and Righellis, Inc. for his support during the project.

DESIGN REPORT
Minto-Brown Island Park Boardwalk

Group 8

June 9th, 2024

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Project Disclaimer

This report was prepared as part of a class project for the Civil and Environmental Engineering Project Management and Design course at Portland State University. The contents of this report were developed by the student authors and do not necessarily reflect the views of Portland State University. The analyses, conclusions, and recommendations contained in the report should not be construed as an engineering report or used as a substitute for professional engineering services.

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Executive Summary

Minto-Brown Island Park is an approximately 1,200 acre park and wildlife refuge located just south of the Willamette River in Salem, Oregon. Among other amenities, the park features 29 miles of trails for bicyclists and pedestrians. Located on the eastern side of the park is a roughly quarter-mile stretch of trail that lies adjacent to the Willamette Slough. The resurgence of the local beaver population has led to natural damming of nearby waterways. The beaver dams have since caused consistent flooding to parts of the park, with prominent effects to the east-side trail section. For approximately half of the year this stretch of trail is rendered unusable in its current state due to varying degrees of flooding. The client requested that a design solution be drafted that maintains accessibility of the path for an extended portion of the year.

The existing trail on the site spans 0.45 miles alongside the Willamette Slough. Our proposed boardwalk design includes a new linear pathway that spans 0.23 miles and sits at a slightly higher elevation, thereby minimizing the impact of seasonal flooding. By maintaining the existing trail with the inclusion of the boardwalk, patrons of the park will have the opportunity to select their preferred route based on current site conditions, ensuring the trail remains operational year-round.

As Minto-Brown Island Park is home to several protected species, our team performed comprehensive analysis on the array of available materials and boardwalk design options to ensure that the environmental disturbance would be minimized, while at the same time providing longevity and minimal ongoing service maintenance. This analysis resulted in an elevated boardwalk fixed to concrete pillars being the proposed design. The boardwalk will be of sufficient width to accommodate two-way traffic consisting of runners, pedestrians, bicyclists, assisted mobility device users, and all-terrain vehicles for civic use. The boardwalk platform will reach a maximum height of one foot from the ground surface at all points. The platform will feature a raised curb edge rather than a railing. The curb, while not mandatory, will help ensure pedestrians stay on the boardwalk and not disturb the surrounding environment.

The proposed boardwalk design for the Minto-Brown Island Park will benefit the community in several ways. Firstly, by extending the accessibility of the park, patrons will be able to enjoy the trails and wildlife for a majority of the year. Second, the addition of an elevated boardwalk minimizes the impact of seasonal flooding and creates a safe pathway for pedestrians of all abilities. Additionally, the selection of materials and pathway design reflects the City of Salem's commitment to sustainability while preserving the surrounding protected wildlife and ecosystem.

Introduction

Located along the Willamette River near downtown Salem, Oregon, Minto-Brown Island Park is subject to extended flood events that limit pedestrian access during wet periods throughout the year. Beaver dams divert and pool water which can leave the trails submerged. Salem's seasonally wet climate, in addition to the surge in river levels due to snow melt, and the resurgence of beavers necessitates a design alternative extending the usability of the flooded trails during these times. The City of Salem has partnered with a Portland State University Capstone team to reach a design solution for this problem.

1.0 Project Background

The Minto-Brown Island Park Boardwalk project analyzes alternatives and provides a solution to an asphalt trail seasonally covered by flood waters, rendering the pathway unusable to park users and city staff. This project aims to extend the use of frequently trafficked trails, while maintaining useability for all park patrons. Careful consideration will be given to the wildlife habitat restoration currently in progress, as well as the aesthetics of the surrounding park.

Project Overview

Minto-Brown Island Park located at 2200 Minto Island Rd SE in Salem, Oregon is a natural area and designated city park. It provides critical wildlife habitat while serving as one of the most popular destinations for outdoor recreation in Salem. The park consists of reclaimed agricultural land along the Southeastern bank of the Willamette River, including orchards, fields, wetlands, and wooded areas (Master Plan, 2015). The park is known for its wildlife viewing and extensive network of interconnected paths and trails. In 2013 the City of Salem added a 307 acre "Conservation Area" section managed by Oregon Department of Fish and Wildlife (ODFW) and the Bonneville Power Administration (BPA) (Conservation Plan, 2015). The project site, also known as the East Field (EF), neighbors the established "Conservation Area" and is experiencing use interruptions for park patrons due to seasonal flooding.

Minto-Brown Island Park lies entirely within the 100-year flood plain of the Willamette River mapped by the Federal Emergency Management Agency (FEMA) and is often seasonally flooded, including the East Field site location. The site's floodplain distinction protects the park from future developments by state and federal law (Master Plan, 2015). The flooding often results in seasonal closures of the EF trail system along the bank of the Willamette Slough. Moreover, the repopulation of beaver has led to more extensive periods of flooding to selective trails, including the paths around the East Field. The EF is now inundated several times a year, due to high water along the Willamette Slough.

The 2015 Master Plan for the park identified future additions of a boardwalk to elevate and detour the EF path around the problem area (Figure 1). Alternative solutions not mentioned in the Master Plan are also considered as potential solutions to the persistently flooded EF trail.

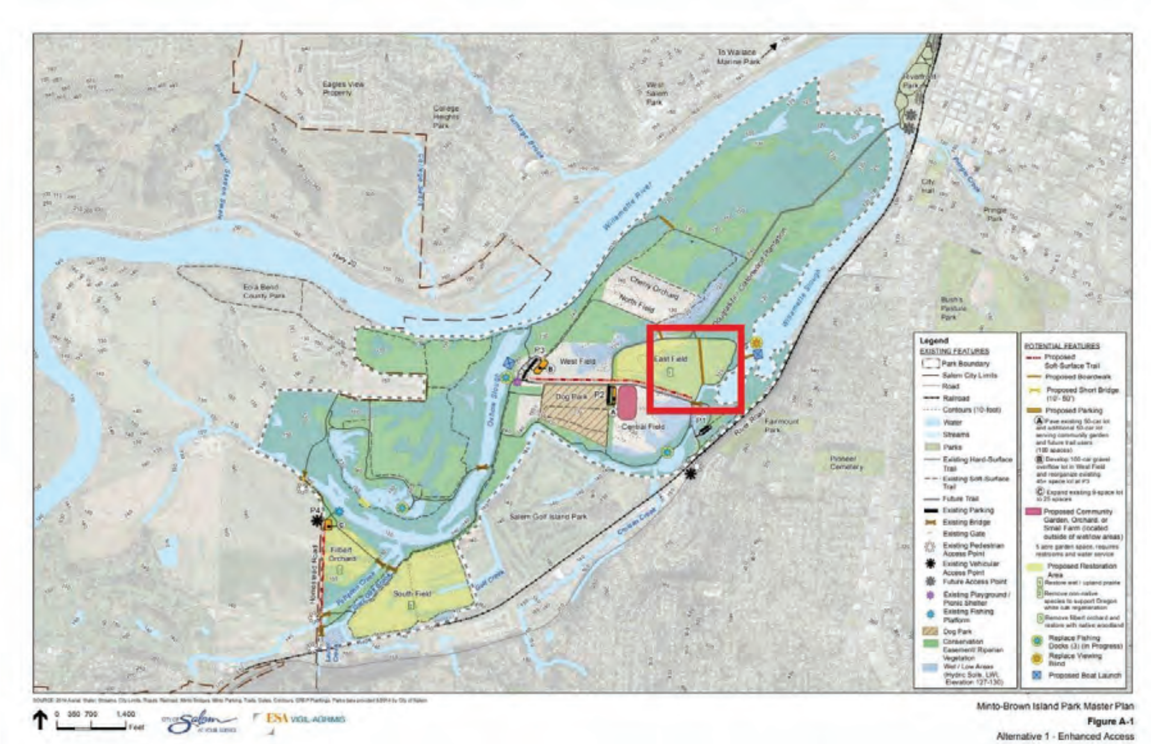

Figure 1: Alternative Plan 1, with the original proposed boardwalk location boxed in red. (Source: Minto-Brown Island Park Master Plan, 2015)

Existing Site Conditions

Minto-Brown Island Park encompasses more than 1,200 acres and is located near the downtown district of Salem, Oregon. The park is bounded by the Willamette River to the north and west, the Willamette Slough to the east, River Road South, the Burlington Northern and Santa Fe Railway (BNSF) to the south. The Oxbow Slough also traverses the park, along with multiple creeks and ponds. The park includes an extensive trail system, with roughly 29 miles of mixed use access (pedestrian, cyclist, and ADA usage) throughout the site (Figure 2). The project site is located within the EF, along the Willamette Slough.

Figure 2: Minto-Brown Island Park Trail Map (Source: City of Salem)

The EF lies within a former agricultural field that has been left fallow after farming practices were terminated within the park. Currently the field consists of reed canarygrass, mowed blackberry bushes, and other grasses (Master Plan, 2015). A portion of the EF along the banks of the Willamette Slough is designated wetland and frequently floods, increasingly following the reintroduction of beavers. The field is left natural and only mowed occasionally by the parks department. The wetland designation, frequent flooding, and natural habitat within the site area, provide the City of Salem with an ideal location for habitat restoration within the park. Considering the environmental factors, great care is needed to preserve the natural habitat throughout the development of this trail improvement project.

Twelve different types of soil are found within the park. Figure 3 shows a red boxed area around the EF which indicates the project area, with "hydric soils" and "soil w/ hydric components" designated within the area (Master Plan, 2015). The Natural Resources Conservation Service (NRCS) defines hydric soil as soil containing an anaerobic layer near the surface due to extended saturation due to flooding or ponding. The hydric soil is found along the bank of the Willamette Slough and intrudes into the EF in low lying areas. The hydric soil extends into the field away from the bank of the slough, these soils are often associated with the presence of wetlands.

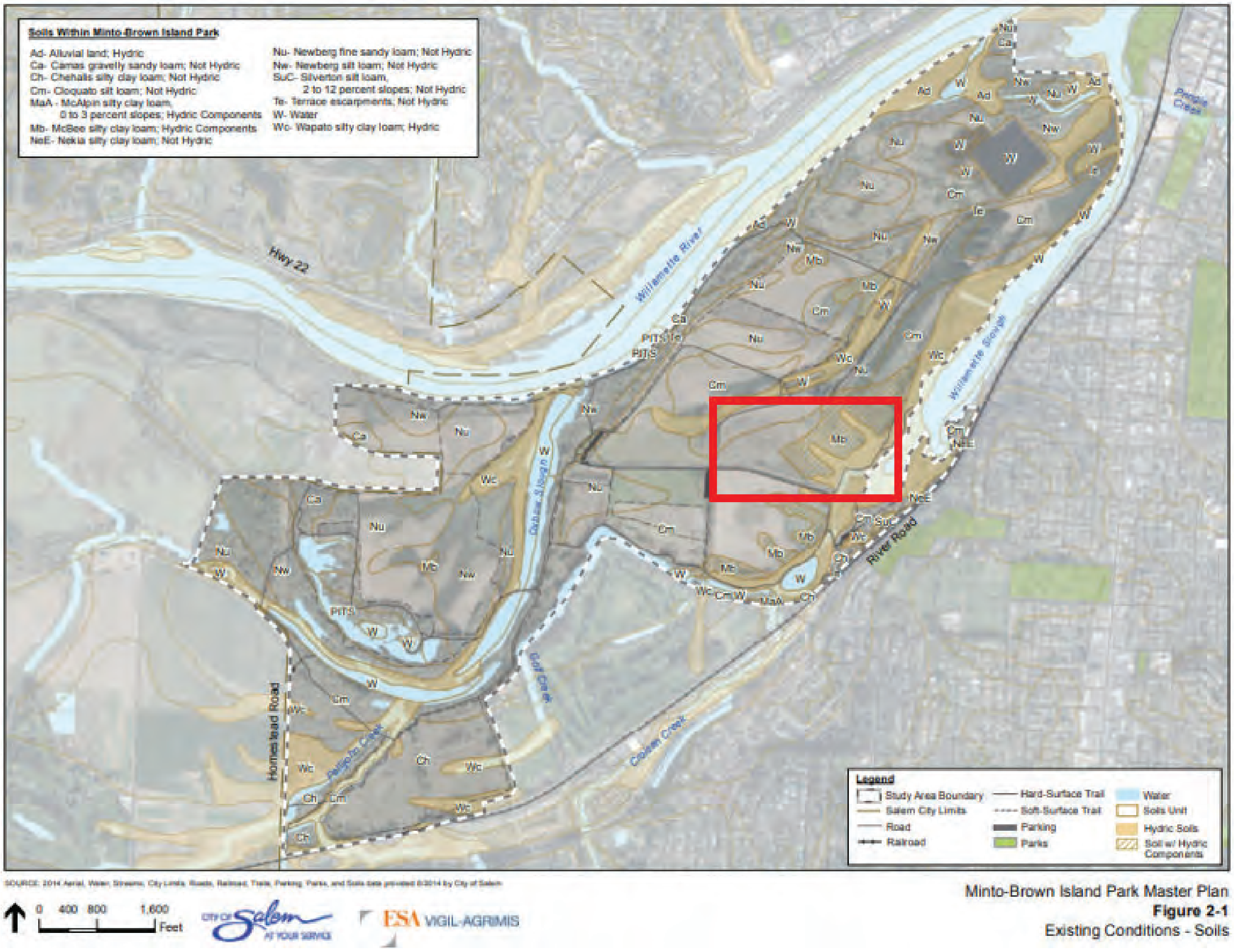

Figure 3: Existing conditions - soils, with East Field soils boxed in red.
(Source: Minto-Brown Island Park Master Plan, 2015)

STAKEHOLDERS

The primary stakeholder for this project is the City of Salem. The City of Salem has a responsibility to its residents, the environment, and a financial stake in this project. Project resources are the City of Salem's fiscal responsibility, unless grant funding can be secured for the project. As the client, the City of Salem and its staff, including Parks Planner Robert Romanek and Project Manager Aaron Kimsey have the final decision making authority in regards to the design and construction of the Minto-Brown Island Park Boardwalk project. The City of Salem has a responsibility to its residents and park patrons to ensure that trails remain accessible during flooding, that Americans with Disabilities Act (ADA) requirements are fulfilled, environmental standards are considered, and that the natural beauty of the park is preserved.

Another stakeholder of this project are the park patrons. Salem residents have a civic and financial stake in this project. The civic stake is rooted in the expanded access to the trail offered by this project. The financial stake stems from the use of public funding used for the project design and construction. If implemented successfully, this project will allow for use of the park trail system for an extended period of the year. The residents' civic and financial stakes require that their opinions be relevant to the outcome of the project. Residents' opinions on the effectiveness of the project are also relevant, as the trail is an important link between sections of the city for pedestrians and cyclists.

The Parks and Recreation division that maintains the park and its trail system is also a stakeholder. The cost of operation and maintenance to the trail is the responsibility of the Parks Department. In the trail's current condition, the Parks Department is only required to do minimal maintenance. The installation of a flood-proof trail could lead to increased maintenance costs or even costs due to vandalism. Parks Department staff also utilize small all-terrain recreational vehicles (ATV) that need to be considered in the design of the trail alternative. The design solution must accommodate the use of these vehicles, as well as other trail traffic.

Lastly, BPA and ODFW hold a joint Conservation Easement adjoining the project location. They are tasked with managing 307 acres of wildlife habitat with limited trail access just North of the project site. BPA provided funding for the conservation easement to restore habitat for fish and other wildlife affected by the construction and operation of Willamette River dams. It is within their interest to maintain that the environmental integrity of this project is in keeping with their conservation management efforts.

2.0 Alternatives Analysis

Three alternatives for increasing accessibility within the EF trial during flood events are evaluated in this analysis. A discussion of the alternatives and utilization of a Pugh Matrix, meant to compare and contrast the merits of these designs, is laid out in the following sections.

Alternative 1: Floating boardwalk

A floating boardwalk consists of a series of connected panels resting on top of a network of buoys. Under flood conditions the buoys elevate the platform to allow the walkway to still function effectively for pedestrian and bicycle traffic. These designs are common in the construction of piers and wharves. See Figure 4 for an example of a floating boardwalk.

Figure 4: **A 600m floating boardwalk. (Source: https://www.leitrimireland.com/listings)**

The materials evaluated for the construction of the boardwalk included timber, composite material, and pressure treated wood, while the buoyant elements considered were polyethylene and steel tubing. A significant limitation of this concept is the client's stipulated design elevation of a one foot maximum height. The design must incorporate floats that produce sufficient buoyant force to meet the Oregon State Marine Board specification of 40-psf uniform live load for a floating walkway.

During dry seasons, the boardwalk would rest on top of the buoys, potentially creating an unstable platform. The use of ATV vehicles is also hindered by the instability of the floating boardwalk, regardless of wet or dry conditions.

Alternative 2: Embankment

An embankment consists of a raised, molded, and compacted section of earthwork to create a pathway that is functional during both the wet and dry seasons. Embankments are often used to mitigate the effects of high water in flood prone areas. Constructed from compacted medium (sand, gravel, native soils, compost) embankments divert or retain flood waters. (Alberta Water, 2023). The main purpose of this embankment is to raise the pedestrian footpath above the flooded area and retaining the floodwater is not the intention, see figure 5 for an example of a raised trail. One positive aspect of an embankment would be the ability to landscape native plants to increase the esthetic of the berm. Geocell ground grid can be incorporated into the design to create topsoil minimizing the risk of soil erosion, providing suitable planting medium.

Figure 5: An 18 foot tall embankment trail. (Source: Minnesota Pollution Control Agency)

The embankment would be constructed along the existing asphalt trail nearest to the Willamette Slough. Removal of the existing pathway and substantial earthwork would both be required to reach a buildable foundation. The embankment would then be constructed from a combination of materials; several lifts of compacted ¾ inch minus gravel would be used in the foundation and throughout the embankment. For stability and safety purposes, the embankment would utilize side slopes of 3:1, with a raised trail height of 5 ft from the original trail elevation.

The possibility of a secondary embankment trail was also considered. This new trail (which can be seen on Alternative A in the park's Master Plan), would run across the East Field, allowing park visitors to bypass the muddy section of the trail, which would remain at its original elevation and remain open for use in the dry season. The alternative trail would utilize the same construction methods: several lifts of ¾ inch minus gravel, 3:1 slopes, and a raised trail height of 5 ft above the existing ground.

Alternative 3: Elevated boardwalk

The elevated boardwalk alternative consists of a series of panels or decking, typically made of timber, composite, or sometimes concrete. The boardwalk is fixed in place to foundational columns, typically steel reinforced cast in place concrete, with members along the span of the boardwalk. Curbs are typically used in low elevation boardwalks for pedestrian safety and to dissuade pedestrians from walking onto protected areas. A drawback to this design is that under excessive flood events it would be submerged and unusable until the waters recede.

Figure 6: A meandering elevated boardwalk.
(Source: https://trailconference.org/destination/pochuck-boardwalk-appalachian-trail)

To avoid the majority of flood inundated areas, a more direct trail, running across the East Field is proposed, allowing park visitors to bypass the muddy section of the trail. The proposed trail will elevate the trail above the flooded areas by moving further away from the Willamette Slough, and by increasing the elevation of the walking path.

2.1 Criteria

Evaluation of five criteria are conducted in this section. The criteria are feasibility, maintenance, construction cost, environmental impact, and bicyclist and pedestrian safety impact. Each criteria is assigned to a "weight" category. The criteria are assigned either "high," "medium," or "low," based on the importance of the criteria to the overall project. Criteria weighted "low" receive values of 1 to 3, criteria weighted "medium" receive values of 1 to 5, and criteria weighted "high" receive values of 1 to 10. Let it be noted that none of the criteria were placed in the "low" category. The alternative that scores the highest values across all criteria will be selected as the desired solution.

Criteria	Weight
Feasibility	High (Max score: 10)
Maintenance	Medium (Max score: 5)
Construction Cost	High (Max score: 10)
Environmental Impact	High (Max score: 10)
Bicyclist & Pedestrian Safety/Impact	Medium (Max score: 5)

Table 1: Criteria Descriptions

Criteria weighted high are feasibility, construction cost, and environmental impact. Construction cost is chosen because the budget for this project is limited, an assessment of the cost of earthwork, materials, and labor. Environmental impact is deemed important due to the conservation area and wetlands where the site is located. It is essential that the design be environmentally sensitive and introduce the least amount of habitat disturbance from construction and any subsequent changes to the system. The feasibility of the project is assessed on whether the plan will be accepted by the client and other stakeholders.Medium weights are assigned to maintenance and user safety. Although safety is essential to all projects, each alternative will be designed to code, making safety a priority and less of a distinguishing factor between alternatives. The maintenance required for the long term upkeep of the project is a contributing factor to the final choice. The ability of the trail to remain open throughout the year is the main contributing factor for the construction of a new trail. Assuring that the trail only requires minor maintenance is important for the overall longevity of the design.

Criteria	Possible Scores	Conditions
Feasibility	1	City of Salem will not approve
	10	City of Salem will approve
Maintenance	1	Extensive setup and maintenance
	3	Moderate setup and maintenance
	5	Low setup and maintenance
Construction Cost	1	High Cost
	5	Moderate Cost
	10	Low Cost

Criteria	Possible Scores	Conditions
Environmental Impact	1	High environmental impact and/or change
	5	Moderate environmental impact and/or change
	10	Low or no environmental impact and/or change
Bicyclist & Pedestrian Safety/Impact	1	No improvement in cyclist or pedestrian safety
	3	Improvement in cyclist or pedestrian safety
	5	High improvement in cyclist or pedestrian safety

Table 2: Criteria and weighting

2.2 Alternative Scoring

The three alternatives are scored on each of the 5 criteria in the table below. An explanation for each alternative score then follows the table.

Criteria	Score Range	Alternative 1: Floating Boardwalk	Alternative 2: Raised Embankment	Alternative 3: Elevated Boardwalk
Feasibility	1 to 10	3	5	10
Maintenance	1 to 5	1	2	5
Construction cost	1 to 10	5	1	7
Environmental impact	1 to 10	7	4	7
Bicyclist/Pedestrian safety & impact	1 to 5	3	5	5
Total Score		19	17	34

Table 3: Final Results

Alternative 1 - Floating Boardwalk

Out of a possible 40 points, the floating boardwalk scored 19. This alternative was evaluated as having limited feasibility, primarily due to a client-imposed design constraint of a 1-foot height limitation, the maintenance criteria scored low due to a high need for maintaining the floats. The Cost in this alternative was estimated to be in between the other two alternatives. The environmental impact was evaluated to be relatively low due to a low amount of disturbance outside of the construction zone, and the Bicyclist/Pedestrian safety & impact scored low due to the potential movement of a floating walkway whilst being utilized. Floating boardwalks are ideal when designing piers over several feet of water. Additionally, the floating boardwalk buoys would be large enough to be an eyesore.

Alternative 2 - Embankment

Out of a possible 40 points the embankment scored 17. This alternative was evaluated as having a low feasibility, primarily due to the extensive earthwork required within a wildlife preservation area, which is anticipated to incur a significantly higher cost. Additionally, the maintenance costs associated with this area are projected to be substantially higher, a consequence of altered water flows that may have need of remedial measures for potential embankment erosion. The Bicyclist/Pedestrian safety & impact scored relatively high due to no potential hazards created in this alternative. All these factors contributed to this alternative receiving the lowest score among all options considered.

Alternative 3 - Standard Boardwalk

Out of a possible 40 points the standard boardwalk scored 34. This alternative was determined to be the most feasible. Due to its simplicity in construction and minimal use of materials, the maintenance on it would be relatively low. The Bicyclist/Pedestrian safety & impact scored relatively high due to there being hazards identified in this alternative. It also received the highest safety rating and had the least environmental impact, leading it to achieve the highest score among all options considered.

Design Selected: Standard Boardwalk

Based on the total score, the standard boardwalk is the chosen solution to the trail accessibility issues. An additional material analysis will be done in order to select the best material for the decking surface.

2.3 Materials Analysis

Given the variety of available materials for decking, an additional alternatives analysis was necessary to arrive at a suitable option. Each material was evaluated for a variety of criteria, including expected lifespan, maintenance needs, weight, cost, and anticipated construction time. Each criteria was weighted by priority (as seen in Table 4), with low scores attributed to undesirable qualities, and high scores attributed to desirable qualities. Material longevity and maintenance costs were chosen as the highest priority criteria over the upfront construction cost based on the theory that a durable material will cost less in the long run than a less expensive material which requires frequent maintenance and regular replacement. Construction time was placed at the lowest priority due to the fact that the nature of the material is not expected to affect the construction time significantly.

Criteria	Description	Weight
Lifespan	Material longevity (years)	High (Max score: 10)
Maintenance	Required frequency of upkeep	High (Max score: 10)
Unit weight	Material weight	Medium (Max score: 5)
Cost	Upfront construction cost	Medium (Max score: 5)
Construction duration	Expected time to completion	Low (Max score: 3)

Table 4: Criteria and Weighting Descriptions

Alternative 1 - Precast Concrete

Precast concrete boardwalks maintain the aesthetics of a traditional wooden boardwalk while reducing maintenance cost and increasing the expected lifespan. Concrete is also a more slip-resistant surface, which is a high priority for pedestrian safety on a walkway in a wetland floodplain. Drawbacks to this material include its upfront cost and unit weight, however, an argument can be made for the benefit of the additional weight in resisting buoyant forces from flood water.

Figure 7: An elevated concrete boardwalk with precast concrete curbs. (Source: https://lockesolutions.com/concrete-boardwalk/)

Alternative 2 - Pressure-Treated Lumber

Pressure-treated lumber was also considered for decking. Boardwalks are traditionally made of wood materials, which is readily available in the Pacific Northwest. As a natural material, pressure treated lumber can blend well with natural environments, making it a more attractive material choice. Construction of lumber boardwalks is generally straightforward, and contractors with extensive experience are readily available. The drawbacks to this material are the frequent maintenance required to maintain its appearance and utility, its potential to leach harmful chemicals, and the possibility of rotting and warping due to moisture. The last two points are especially a concern due to the site's floodplain classification.

Fig. 8: Elevated Lumber Boardwalk.
(Source: https://goodstock.photos/wp-content/uploads/2020/07/Railed-Wooden-Boardwalk-in-Nature-1920x1280.jpg)

Alternative 3 - Composite Decking

Composite decking was an alternative also considered for the boardwalk. This material mimics the natural look of lumber while eliminating the warping concerns. Depending on the brand, composite decking can have a textured surface that is less likely to be hazardous to pedestrians while wet than lumber, as well. It can also be cut to size on site, like lumber, but it is a plastic-based material, which presents long-term environmental hazards.

Figure 9: A Composite Decking Boardwalk, located in Bend, OR.
(Source: https://www.bendparksandrec.org/park/drake-park-and-mirror-pond/)

Criteria	Alternative 1: Precast Concrete	Alternative 2: Pressure-Treated Lumber	Alternative 3: Composite Decking
Lifespan	10	6	8
Maintenance	10	5	7
Unit weight	2	4	4
Cost	3	4	4
Construction duration	2	3	3
Total score	**27**	**22**	**26**

Table 5: Scoring Totals

Material Selected: Precast Concrete

The final design selected is an elevated boardwalk made of precast concrete. Its durability and minimal maintenance costs factored heavily in the decision, where it was far ahead of pressure-treated lumber, and surpassed composite decking primarily based on long-term environmental concerns.

3.0 Design Development

The City of Salem approached our team to design a walkway that allows access to a waterfront area that experiences frequent flooding throughout the year. The client noted a raised path less than three feet in height would be required to maintain code without the need for additional handrails. The path in its current state was measured to be approximately one quarter of one mile in length. The path would need to accommodate two-way traffic of park patrons, including pedestrians, runners, bicyclists, people with mobility devices, strollers, and ATVs.

Figure 10: Proposed trail realignment for precast concrete boardwalk.

Proposed is a precast concrete elevated boardwalk of roughly 0.23 miles, removed from the original trail alignment along the Willamette Slough. The proposed alignment traverses the East Field and more directly connects to the trail system, while avoiding heavily flooded areas. The proposed alignment also increases the elevation of the trail, the new elevation of 121-122 feet above sea level compared to the original trail elevation of 117-118 feet above sea level, raising the trail further out of the floodwaters. The original Minto-Brown Island Park Master Plan suggests a similar path for the boardwalk (Master Plan, 2015). However, the suggested design has a straight line path, as opposed to a curved trail. The trailhead location is also altered from the Master Plan, moving the start of the boardwalk to the trailhead of the East Field to avoid extreme flooding that would render the boardwalk inaccessible.

The precast concrete boardwalk system is composed of four separate elements, foundation, substructure, superstructure, and curbs. The foundation will be cleared and excavated before drilling and casting the steel reinforced concrete footings at 20 ¼ feet on center. The precast concrete beams will connect each footing and 1 foot wide precast concrete treads will span the path. The path width of 12 feet is required to allow for the safe passage of park users, ADA requirements, as well as Parks and Recreation ATV's. The 12 foot wide treads will be supported at each end with 1 foot of overhang, as seen in figure 10. Following the construction of the precast concrete walkway, ADA accessible ramps will be constructed at the terminal ends of the boardwalk with primary slopes of no more than 5% and cross slopes of no more than 1.5%. Precast concrete curbs will also be installed on the deck of the boardwalk to direct traffic away from the edges.

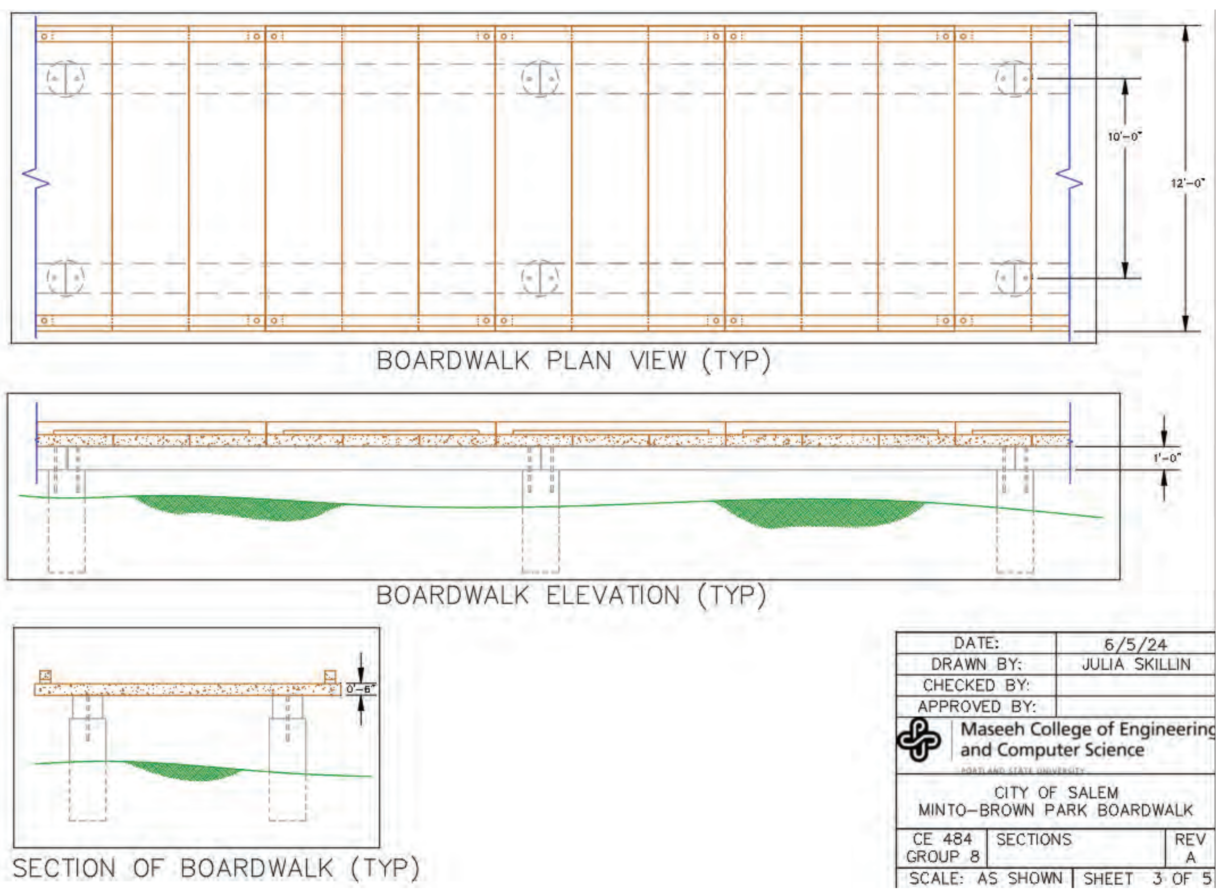

Figure 11: AutoCAD Civil 3D rendering of the proposed precast concrete boardwalk.

The precast concrete boardwalk system should be supplied by PermaTrak or another precast concrete boardwalk supplier with approval from the engineer. PermaTrak will provide engineering services and support throughout the design and installation of the project. Initial boardwalk dimensions of 12 ft x 0.5 ft for treads, 20 ft x 1 ft for beams, and circular footings with a 1 ft radius will be confirmed by the supplier.

3.1 Calculations

The precast concrete boardwalk system is designed to facilitate accessibility for park patrons, as well as the use of all terrain vehicles by the Parks and Recreation Division. For these design characteristics, loadings are evaluated from the top down for the treads, beams, and footings of the boardwalk. For the stringers, dead and live loads of 1.2 kips per foot are used. Each beam is 20 feet long and will support 20 individual 1-foot wide treads. The treads span a width of 10 feet with a one foot overhang on either side of the boardwalk. They are designed with reinforcement of 2 #3 bars to withstand forces. Calculations for all members are laid out in appendix B.

The beams that will be supporting the tread were then designed to support the load of the treads, including live and dead load, as well as the beams self-weight. The columns were not designed due to time and it is therefore recommended that these be investigated.

3.2 Soil Testing

The project site lies in an environmentally sensitive area consisting of hydric alluvial soils. Indeed a number of soils in the Willamette Valley are designated as alluvial silt and need special attention for design. Atterberg limits conducted on six soil samples can be seen in Appendix C of this document. Samples taken from two locations in the East Field of Minto-Brown park revealed that the soils consisted mainly of low and high plasticity silt (USCS: ML or MH). Samples taken were roughly 6 inches in length, from depths below ground surface from 1.5 to 4 feet in each location. Plastic indexes (PI) ranged from 18 in the MH silt to 7 in the ML silt.

The two locations for soil testing correspond to proposed boardwalk alignment traversing the East Field between the trailhead and the connecting trail that connects Minto-Brown Island Park and Riverfront City Park. At these locations, the water table was encountered between 2 and 3 feet below ground surface, a similar elevation to the nearby slough, suggesting that water levels mirror surface water elevations. In order to determine the likelihood of settlement along the length of the boardwalk, more soil tests will need to be performed. Until those tests are completed, some variables can be estimated based on similarities between other soils with similar plastic indices and soil classifications.

Using the uniform loading of a circular footing calculation, and some assumptions about the soil properties and loading, settlements are expected to be just over an inch for each footing.

3.3 Construction Schedule

Project construction begins July 1st, 2024. Prior to breaking ground, a number of items need to reach completion. Pre-construction, Site Investigation, and Site preparation are allotted roughly 2 weeks for completion. Following pre-construction, excavation on the site can begin. Construction is divided into two sub-sections, foundation and boardwalk. Foundation construction includes excavation, elevation check, footing installation (drilling, rebar, and pouring concrete), compaction, and final grade checks. The boardwalk construction takes place in three steps, column installation, stringer installation, and precast concrete slab/tread installation. Installation of precast concrete stinger and slab/treads requires the use of a construction crane. Following completion of the boardwalk installation, a week will be left for site clean up and final landscaping. If the construction goes to plan, the project is scheduled to be completed Sept. 10th, 2024.

With a construction project of this scale located in a sensitive area, care must be taken to ensure that the environment is protected from contamination. Erosion control bales and sediment fences are required along the project boundary to reduce contamination of waterways. Concrete washouts are to be placed and used for any concrete in excess of foundation needs, and from washing trucks before leaving the construction site. A temporary access road can be constructed if necessary for access of construction vehicles on-site. Otherwise the existing trail should be used for traffic in and out of the area. If for any reason construction will not be finished prior to October 15th, 2024, plans must be made to ensure that grass seed and straw bales are utilized for site stabilization in concordance with City of Salem standards.

3.4 Cost Estimate

The budget provided by the City of Salem for this project is roughly $2 million. Similar park projects have been undertaken by other municipalities in Oregon and have reached prices including design, labor, materials, and construction of upwards of $7 million. The cost estimate for the construction of the Minto-Brown East Field Boardwalk is an initial estimate of material, labor and equipment costs. Costs were broken down into three separate sections: foundation, substructure, and superstructure. The foundation is broken down into two items– clearing and excavation. Estimates for the superstructure are based on precast concrete planks, columns, curbs and beams, as well as cast-in-place ramps. The estimated construction cost for the project can be seen in Appendix D and the bottom line is $1,384,600.

3.5 Landscaping

Following the completion of construction disturbed areas are to be reseeded with an approved grass seed mix that matches the current diversity of grass types. The dominant existing grass found in the East Field is reed canary grass. According to best management practices set forward by the City of Salem, seeding shall take place at a rate of 100 pounds per acre minimum. To ensure that adequate grass cover is achieved by October 15th, 2024, it is recommended that seeding and mulching take place prior to September 1st, 2024.

Depending on the desires of the client, trees and shrubs should be introduced to the area to provide shade, interest and protection to the boardwalk trail area. There is currently limited vegetation along the proposed trail area. The addition of vegetation can reduce the likelihood of erosion during flooding and can also increase the aesthetics of the project site. Recommendations for vegetation that can tolerate high floodwaters and drought conditions should be researched prior to planting. See City of Salem detail 803 for proper planting technique.

4.0 Design Requirements, Regulatory Compliance, and Permitting

The boardwalk construction process involves extensive communication and compliance with numerous regulatory agencies to be granted the required permits. Initial stages require securing a wetland permit from the Department of State Lands and the Army Corps of Engineers. Additionally, the State Office of Historic Preservation needs to be consulted to ensure the site does not contain Native American artifacts and is not a cultural heritage site.

After the permits are acquired, the project will undergo land use and site plan reviews that will focus on acquiring additional permits relating to zoning regulations and environmental protections.

As this project proposal involves ground disturbance, all parties involved must maintain compliance with the National Environmental Protection Act (NEPA).

5.0 Conclusion

The proposed boardwalk design for Minto-Brown Island Park offers a comprehensive solution to the challenge posed by seasonal flooding while enhancing the accessibility of the trail network. By providing an alternative linear route located at a higher elevation, the boardwalk allows for continued trail use year-round for members of the community to continue to enjoy the local wildlife and ecosystem. The selection of materials and construction design reflects the City of Salem's commitment to sustainability and environmental stewardship. The implementation of an elevated boardwalk to Minto-Brown Island Park will benefit the community by improving access to the expansive network of existing trails.

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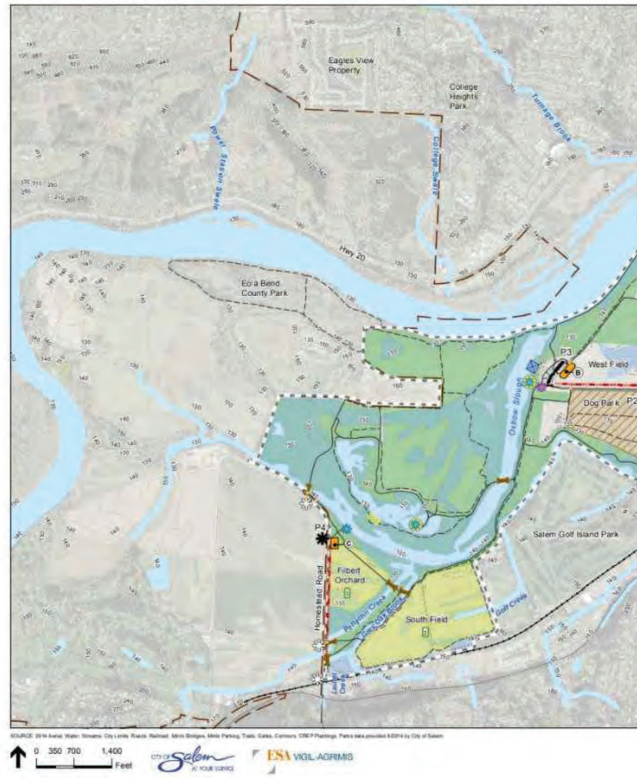
Appendices

The following appendices are attached:

APPENDIX A
DRAWINGS

MINTO—BROWN ISLAND PA

PREPARED FOR THE CITY OF SALEM
BY:
John Zaikoski
Colby Seifert
Anna Sosa
Caitlin Jacobson
Scott Allan
Julia Skillin



VICINITY MAP

GENERAL NOTES

PRE—CONSTRUCTION

1. PRIOR TO ANY LAND DISTURBING ACTIVITIES, THE BOUNDARIES OF THE CLEARING AND GRADING LIMITS, VEGETATED BUFFERS, AND ANY SENSITIVE AREAS SHOWN ON THIS PLAN SHALL BE CLEARLY DELINEATED IN THE FIELD. UNLESS OTHERWISE APPROVED. NO DISTURBANCE IS PERMITTED BEYOND THE CLEARING LIMITS. THE CONTRACTOR MUST MAINTAIN THE DELINEATION FOR THE DURATION OF THE PROJECT. NOTE: VEGETATED CORRIDORS TO BE DELINEATED WITH ORANGE CONSTRUCTION FENCE OR APPROVED EQUAL.
2. BMPS THAT MUST BE INSTALLED PRIOR TO LAND DISTURBING ACTIVITIES ARE CONSTRUCTION ENTRANCE, PERIMETER SEDIMENT CONTROL, AND INLET PROTECTION.
3. HOLD A PRE—CONSTRUCTION CONFERENCE TO REVIEW THE EPSCP AND WITH THE CITY'S PROJECT MANAGER AND INSPECTOR.

CONSTRUCTION

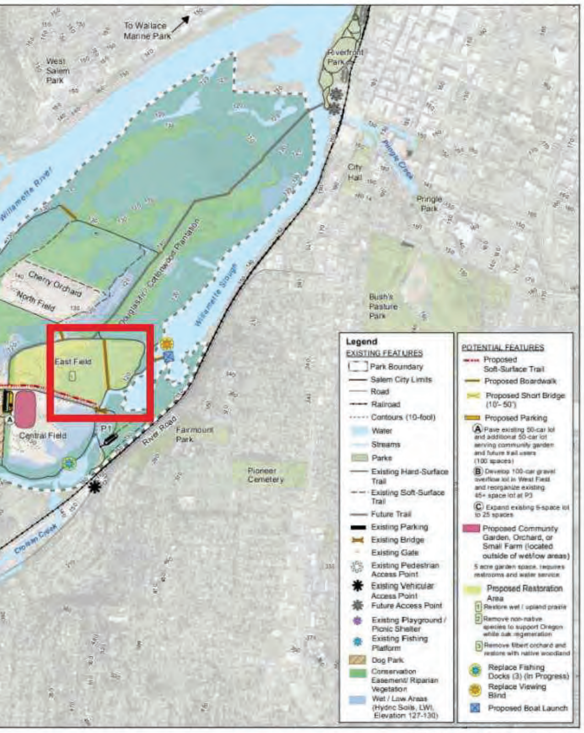
1. ALL SEDIMENT IS REQUIRED TO STAY ON SITE. SEDIMENT AMOUNTS GREATER THAN ½ CUBIC FOOT WHICH LEAVE THE SITE MUST BE CLEANED UP WITHIN 24 HOURS AND PLACED BACK ON THE SITE AND STABILIZED OR PROPERLY DISPOSED. VACUUMING OR DRY SWEEPING MUST BE USED TO CLEAN UP RELEASED SEDIMENT AND IT MUST NOT BE SWEPT OR WASHED INTO STORM SEWERS, DRAINAGE WAYS, OR WATER BODIES.THE CAUSE OF THE SEDIMENT RELEASE MUST BE FOUND AND PREVENTED FROM CAUSING A RECURRENCE OF THE DISCHARGE WITHIN THE SAME 24 HOURS. ANY IN—STREAM CLEAN UP OF SEDIMENT SHALL BE PERFORMED ACCORDING TO THE DSL REQUIRED TIME FRAME.
2. CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF EROSION PREVENTION AND SEDIMENT CONTROL FACILITIES IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED, APPROVED, AND PERMANENT EROSION CONTROL (I.E., VEGETATION/LANDSCAPING) IS ESTABLISHED ON ALL DISTURBED AREAS.
3. ALL RECOMMENDED EROSION PREVENTION AND SEDIMENT CONTROL PROCEDURES ARE DEPENDENT ON CONSTRUCTION METHODS, STAGING, SITE CONDITIONS, WEATHER, AND SCHEDULING. DURING THE CONSTRUCTION PERIOD, EROSION CONTROL FACILITIES SHALL BE REVISED, UPGRADED, REPLACED, OR ADDED, TO COMPLY WITH SRC AND STATE AND FEDERAL REGULATORY REQUIREMENTS.
4. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR PROTECTION OF ALL ADJACENT PROPERTY AND DOWNSTREAM FACILITIES FROM EROSION AND SILTATION DURING PROJECT CONSTRUCTION. ANY DAMAGE RESULTING FROM SUCH EROSION AND SILTATION SHALL BE CORRECTED AT THE SOLE EXPENSE OF THE CONTRACTOR.
5. WHEN SATURATED SOIL IS PRESENT, WATER—TIGHT TRUCKS MUST BE USED TO TRANSPORT SATURATED SOILS FROM THE CONSTRUCTION SITE. SOIL MAY BE DRAINED ON SITE AT A DESIGNATED LOCATION, USING APPROPRIATE BMPS. SOIL MUST BE DRAINED SUFFICIENTLY TO DRIP LESS THAN ONE GALLON PER HOUR PRIOR TO LEAVING THE SITE.
6. ALL MATERIALS SPILLED, DROPPED, OR WASHED INTO STORM DRAINS MUST BE REMOVED IMMEDIATELY, AND THE CONTRACTOR SHALL PROVIDE PROTECTION OF DOWNSTREAM INLETS AND CATCH BASINS TO ENSURE SEDIMENT—LADEN WATER DOES NOT ENTER THE STORM DRAIN SYSTEM.
7. ALL DISCHARGE OF SEDIMENT—LADEN WATER MUST BE TREATED WITH AN APPROPRIATE BMP TO REMOVE SEDIMENT FROM DISCHARGE WATER AND TO COMPLY WITH SRC AND STATE AND FEDERAL REGULATORY PERMITS.
8. IN AREAS SUBJECT TO WIND EROSION, APPROPRIATE BMPS MUST BE USED WHICH MAY INCLUDE THE APPLICATION OF FINE WATER SPRAYING, PLASTIC SHEETING, MULCHING OR OTHER APPROVED MEASURES.
9. THE EPSC MEASURES AND BMPS SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE MEASURES SHALL BE UPGRADED AS NEEDED TO MAINTAIN COMPLIANCE WITH ALL REGULATIONS.
10. THE CONTRACTOR SHALL PROVIDE ONSITE WATER OR OTHER APPROPRIATE BMPS TO PREVENT DUST AND WIND EROSION OF FINE GRAIN SOILS.
11. DISTURBED AREAS MUST BE STABILIZED AFTER 14 DAYS OF INACTIVITY, OR IMMEDIATELY IF IS FORECASTED. SEE SUBSECTION 7A.1(D)—WET WEATHER PERIOD.

DURING THE WET WEATHER WORK PERIOD OR WHEN RAIN IS FORECASTED, ALL ACTIVE AND INACTIVE SOIL STOCK PILES MUST BE COVERED WITH APPROPRIATE PLASTIC SHEETING. PLASTIC SHEETING MUST COVER THE ENTIRE STOCK PILE AND BE SUFFICIENTLY ANCHORED.

POLLUTANTS, SOLID WASTE AND HAZARDOUS MATERIALS MANAGEMENT

1. ANY USE OF TOXIC OR OTHER HAZARDOUS MATERIALS MUST INCLUDE PROPER STORAGE, APPLICATION, AND DISPOSAL.
2. THE CONTRACTOR IS SOLELY RESPONSIBLE TO PROPERLY MANAGE POLLUTANTS, HAZARDOUS WASTES, USED OILS, CONTAMINATED SOILS, CONCRETE WASTE, SANITARY WASTE, LIQUID WASTE, OR OTHER TOXIC SUBSTANCES DISCOVERED OR GENERATED DURING CONSTRUCTION TO PREVENT LEAKAGE, SPILLS OR RELEASE OF POLLUTANTS TO THE ENVIRONMENT AND SURFACE WATERS.
3. CONTRACTOR SHALL DEVELOP A PROJECT SPECIFIC WRITTEN SPILL PREVENTION AND RESPONSE PROCEDURES THAT INCLUDES EMPLOYEE TRAINING ON SPILL PREVENTION AND PROPER DISPOSAL PROCEDURES;

ARK BOARDWALK



Minto-Brown Island Park Master Plan
Figure A-1
Alternative 1 - Enhanced Access

DRAWING INDEX

REGULAR MAINTENANCE SCHEDULE FOR VEHICLES AND MACHINERY; AND MATERIAL DELIVERY AND STORAGE CONTROLS, SIGNAGE, MATERIAL USE, AND USE OF COVERED STORAGE AREAS FOR WASTE AND SUPPLIES. THE PLAN SHALL COMPLY WITH SRC AND FEDERAL AND STATE REQUIREMENTS, AND SHALL BE AVAILABLE ON SITE AT ALL TIMES.

WET WEATHER PERIOD (OCTOBER 15 THROUGH APRIL 30)

1. CONSTRUCTION ACTIVITIES MUST AVOID OR MINIMIZE THE DURATION OF DISTURBED AREAS.
2. TEMPORARY STABILIZATION OF THE SITE INCLUDING COVERING OF BARE SOILS WITH APPROVED BMPS, MUST BE INSTALLED AT THE END OF THE SHIFT BEFORE A HOLIDAY OR WEEKEND, OR AT THE END OF EACH WORKDAY IF RAINFALL IS FORECAST IN THE NEXT 24 HOURS.
3. TEMPORARY STABILIZATION OR COVERING OF SOIL STOCKPILES AND PROTECTION OF STOCKPILES LOCATED AWAY FROM CONSTRUCTION ACTIVITY MUST OCCUR AT THE END OF EACH WORKDAY.

MAINTENANCE

1. EROSION CONTROL MEASURES SHALL BE MAINTAINED IN SUCH A MANNER AS TO ENSURE THAT EROSION IS PREVENTED AND SEDIMENT-LADEN WATER DOES NOT ENTER A DRAINAGE SYSTEM, ROADWAY, OR VIOLATE APPLICABLE WATER QUALITY STANDARDS.
2. SEDIMENT SHALL NOT BE WASHED OR SWEPT INTO STORM SEWERS, DRAINAGE WAYS, OR WATER BODIES.
3. SEDIMENT MUST BE REMOVED FROM BEHIND ALL SEDIMENT CONTROL MEASURES WHEN IT HAS REACHED A HEIGHT OF $\frac{1}{3}$ THE BARRIER HEIGHT, AND PRIOR TO THE CONTROL MEASURES REMOVAL.
4. REMOVAL OF TRAPPED SEDIMENT IN A SEDIMENT BASIN OR SEDIMENT TRAP OR CATCH BASINS MUST OCCUR WHEN THE SEDIMENT RETENTION CAPACITY HAS BEEN REDUCED BY 50 PERCENT; IS NOT FUNCTIONING PROPERLY AND/OR AT THE COMPLETION OF PROJECT.
5. CLEANING OF ALL STRUCTURES, INLET PROTECTION BMPS, AND SUMP PUMPS MUST BE COMPLETED REGULARLY AND AS REQUIRED TO ENSURE STRUCTURES AND INLETS FUNCTION PROPERLY AND FLOW FREELY.
6. CONSTRUCTION SITE EXITS SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOW OF MUD ONTO THE ROW OR APPROVED ACCESS POINT. THE ENTRANCE MAY REQUIRE PERIODIC TOP DRESSING AS CONDITIONS DEMAND, AND REPAIR AND/OR CLEANOUT OF ANY STRUCTURES USED TO TRAP SEDIMENT. WHEEL WASHING SHALL BE REQUIRED TO PREVENT SEDIMENT AND MATERIAL TRACKING ON ROAD SURFACES IF PASSIVE BMPS ARE NOT EFFECTIVE.

ABBREVIATIONS

BMPS	BEST MANAGEMENT PRACTICES
DSL	DEPARTMENT OF STATE LANDS
EPSC	EROSION PREVENTION SEDIMENT CONTROL PLAN
EPSCP	EROSION PREVENTION AND SEDIMENT CONTROL PLAN
HDPE	HIGH DENSITY POLYETHYLENE
ROW	RIGHT OF WAY
SRC	SALEM REVISED CODE

DATE:	6/9/24
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APPROVED BY:	

Maseeh College of Engineering and Computer Science
PORTLAND STATE UNIVERSITY

CITY OF SALEM
MINTO–BROWN PARK BOARDWALK

CE 484 GROUP 8	GENERAL NOTES	REV A
SCALE: AS SHOWN	SHEET 1 OF 6	

GENERAL NOTES, CONTINUED

INSPECTION

1. THE EPSCP MUST BE KEPT ONSITE AT ALL TIMES. ALL MEASURES SHOWN ON THE PLAN MUST BE INSTALLED PROPERLY TO ENSURE COMPLIANCE WITH SRC AND STATE AND REGULATORY PERMITS, AND THAT SEDIMENT DOES NOT ENTER A SURFACE WATER SYSTEM, ROADWAY, OR OTHER PROPERTIES.
2. WRITTEN EPSC INSPECTION LOGS SHALL BE MAINTAINED ONSITE AND AVAILABLE TO CITY INSPECTORS UPON REQUEST.
3. ALL BMPS SHALL BE INSPECTED AT LEAST EVERY WEEK. WHEN A RAINFALL EVENT EXCEEDS 1/2" IN A 24-HOUR PERIOD, DAILY INSPECTION OF THE EROSION CONTROLS, SEDIMENT CONTROLS, AND DISCHARGE OUTFALL MUST BE CONDUCTED AND DOCUMENTED. INSPECTIONS SHALL BE DONE BY A REPRESENTATIVE OF THE PERMIT REGISTRANT WHO IS KNOWLEDGEABLE AND EXPERIENCED IN THE PRINCIPLES, PRACTICES, INSTALLATION, AND MAINTENANCE OF EROSION AND SEDIMENT CONTROLS.

INACTIVE CONSTRUCTION PERIODS AND POST-CONSTRUCTION

1. SHOULD WORK CEASE IN ANY AREA FOR 14 DAYS, THE INACTIVE AREA MUST BE STABILIZED WITH APPROPRIATE SOIL STABILIZATION BMPS. IF ALL CONSTRUCTION ACTIVITY CEASES THE ENTIRE SITE MUST BE TEMPORARILY STABILIZED USING VEGETATION, HEAVY MULCH LAYER, TEMPORARY SEEDING, OR OTHER METHOD.
2. ALL TEMPORARY EROSION PREVENTION AND SEDIMENT CONTROL FACILITIES SHALL BE REMOVED BY THE CONTRACTOR WITHIN 30 DAYS AFTER PERMANENT LANDSCAPING/VEGETATION IS ESTABLISHED AND THE THREAT OF EROSION AND SEDIMENT TRANSPORT HAS BEEN MITIGATED.
3. TEMPORARY GRASS COVER MEASURES MUST BE FULLY ESTABLISHED BY OCTOBER 15 OR OTHER COVER MEASURES (I.E., EROSION CONTROL BLANKETS WITH ANCHORS, ONE-INCH OF STRAW MULCH, SIX MIL HDPE PLASTIC SHEET, ETC.) SHALL BE IN PLACE OVER ALL DISTURBED SOIL AREAS UNTIL APRIL 30. TO ESTABLISH AN ADEQUATE GRASS STAND FOR CONTROLLING EROSION BY OCTOBER 15, IT IS RECOMMENDED THAT SEEDING AND MULCHING OCCUR BY SEPTEMBER 1.
4. PERMANENT EROSION CONTROL VEGETATION ON ALL EMBANKMENTS AND DISTURBED AREA SHALL BE RE-ESTABLISHED AS SOON AS CONSTRUCTION IS COMPLETED.

SPECIFICATIONS

SOIL PREPARATION. TOPSOIL SHOULD BE PREPARED ACCORDING TO THE LANDSCAPE PLANS, IF AVAILABLE, OR RECOMMENDATIONS OF THE GRASS SEED SUPPLIER.

5. SEEDING EROSION CONTROL GRASS SEED MIX SHALL BE AS FOLLOWS: DWARF GRASS MIX (LOW HEIGHT, LOW MAINTENANCE) CONSISTING OF DWARF PERENNIAL RYEGRASS (80 PERCENT BY WEIGHT), CREEPING RED FESCUE (20 PERCENT BY WEIGHT). APPLICATION RATE SHALL BE 100 POUNDS PER ACRE MINIMUM.
6. GRASS SEED SHALL BE FERTILIZED AT A RATE OF TEND POUNDS PER 1,000 SQUARE FEET WITH 16-16-16 SLOW RELEASE TYPE FERTILIZER. DISTURBED AREAS WITHIN 50 FEET OF WATER BODIES AND WETLANDS MUST USE A NON-PHOSPHOROUS FERTILIZER.
7. THE APPLICATION RATE OF FERTILIZERS USED TO REESTABLISH VEGETATION SHALL FOLLOW MANUFACTURER'S RECOMMENDATIONS. NUTRIENT RELEASES FROM FERTILIZERS TO SURFACE WATERS SHALL BE MINIMIZED. TIME RELEASE FERTILIZERS SHALL BE USED. CARE SHALL BE MADE IN THE APPLICATION OF FERTILIZERS WITHIN ANY WATERWAY RIPARIAN ZONE TO PREVENT LEACHING INTO THE WATERWAY.
8. WHEN USED, HYDROMULCH SHALL BE APPLIED WITH GRASS SEED AT A RATE OF 2,000 POUNDS PER ACRE BETWEEN APRIL 30 AND JUNE 10, OR BETWEEN SEPTEMBER 1 AND OCTOBER 1. ON SLOPES STEEPER THAN TEN PERCENT HYDROSEED AND MULCH SHALL BE APPLIED WITH A BONDING AGENT (TACKIFIER). APPLICATION RATE AND METHODOLOGY SHALL BE IN ACCORDANCE WITH SEED SUPPLIER RECOMMENDATIONS.
9. WHEN USED IN LIEU OF HYDROMULCH, DRY, LOOSE, WEED-FREE STRAW USED AS MULCH SHALL BE APPLIED AT A RATE OF 4,000 POUNDS PER ACRE (DOUBLE THE ANCHOR STRAW BY WORK (ROLLERS, CLEAT TRACKE UNIFORMLY IMMEDIATELY
10. WHEN CONDITIONS ARE N ESTABLISHMENT OF THE IRRIGATE THE SEEDED AN ESTABLISH THE GRASS C
11. SEDIMENT FENCES SHALL FABRIC TO AVOID USE O FILTER CLOTH SHALL BE POST, WITH A MINIMUM S SECURELY FASTENED TO
12. THE STANDARD STRENGT SECURELY TO ATTACHED THE POSTS, AND SIX INC INTO THE TRENCH. THE F INCHES ABOVE THE ORIG NOT BE STAPLED TO EXI
13. BIO-FILTER BAGS SHALL WASTE. BAGS SHALL BE APPROXIMATELY 45 POUN $\frac{1}{2}$ INCH PLASTIC MESH.
14. MINIMUM WET WEATHER S SLOPES USE BON TERRA C125 EROSION CONTROL STRAW MULCH OR NORTH FLATTER THAN 3H:1V AN THAN 6H:1V USE ONE IN HYDROMULCH AND TACKI ON ALL DISTURBED ARE SECTION AT CONSTRUCTI SEEDING HAS BEEN ESTA OR SEASONAL WORK STO MAY BE PLACED ON EXP PROVIDED WITH AN ANCH THE SLOPE, AND SHALL REQUIRED TO PREVENT D

ATTENTION: OREGON LAW REQUIR OREGON UTILITY NOTIFICATION CE 952-001-0010 THROUGH 952-0 RULES BY CALLING THE CENTER. UTILITY NOTIFICATION CENTER IS

ALL CONSTRUCTION SHALL BE IN STANDARD.

CONSTRUCTION SPECIFICATIONS A PART OF THE APPROVED PLANS.

HYDROMULCH APPLICATION REQUIREMENT).
KING IN BY HAND OR WITH EQUIPMENT
ERS, ETC.). MULCH SHALL BE SPREAD
FOLLOWING SEEDING.
NOT FAVORABLE TO GERMINATION AND
GRASS SEED, THE CONTRACTOR SHALL
ND MULCHED AREAS AS REQUIRED TO
COVER.
BE CONSTRICTED OF CONTINUOUS FILTER
F JOINTS. WHEN JOINTS ARE NECESSARY,
SPLICED TOGETHER ONLY AT A SUPPORT
SIX-INCH OVERLAP, AND BOTH ENDS
A POST.
H FILTER FABRIC SHALL BE FASTENED
LOOPS INSTALLED ON THE UPSLOPE SIDE OF
CHES OF THE FABRIC SHALL BE EXTENDED
FABRIC SHALL NOT EXTEND MORE THAN 30
INAL GROUND SURFACE. FILTER FABRIC SHALL
STING TREES.
BE CLEAN 100 PERCENT WOOD PRODUCT
18-INCH X 18-INCH X 30-INCH, WEIGH
NDS, AND BE CONTAINED IN A BAG MADE OF

SLOPE PROTECTION. FOR 3H:1V OR STEEPER
TYPE C2 OR NORTH AMERICAN GREEN TYPE
BLANKETS. USE A MINIMUM OF TWO INCHES
H AMERICAN GREEN TYPE S150 FOR SLOPES
ID GREATER THAN 6H:1V. SLOES FLATTER
CH STRAW MULCH, HYDROSEED WITH
FIER. SLOPE PROTECTION SHALL BE PLACED
AS IMMEDIATELY AFTER COMPLETION OF EACH
ON ACTIVITY, UNTIL THE EROSION CONTROL
ABLISHED. AS AN OPTION DURING TEMPORARY
OPPAGES, A SIX-MIL HDPE PLASTIC SHEET
OSED SLOPES. THE PLASTIC SHEET SHALL BE
HOR TRENCH AT THE TOP AND BOTTOM OF
BE SANDBAGGED ON THE SLOPES AS
DAMAGE OR DISPLACEMENT BY WIND.

RES YOU TO FOLLOW RULES ADOPTED BY THE
ENTER. THOSE RULES ARE SET FORTH IN OAR
01-0090. YOU MAY OBTAIN COPIES OF THE
THE TELEPHONE NUMBER FOR THE OREGON
503-232-1987.

ACCORDANCE WITH THE CITY OF SALEM

AND ANY SPECIAL PROVISIONS INCLUDED AS A

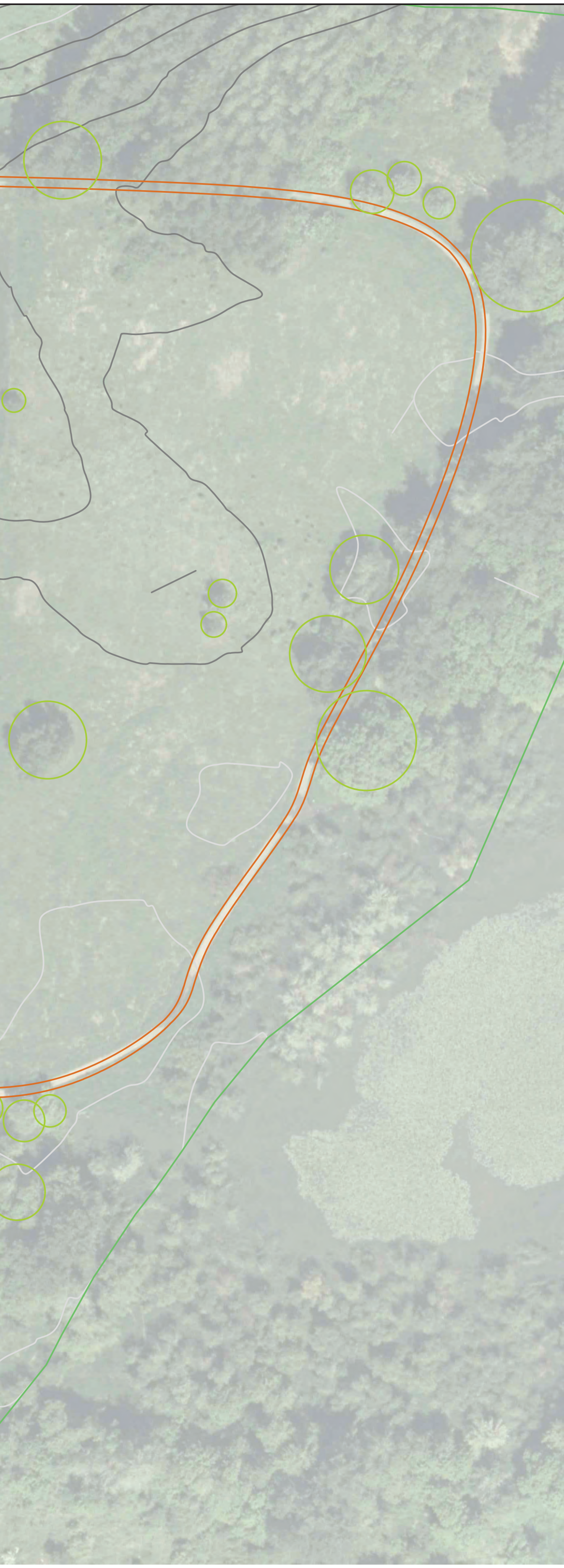
DATE:	6/9/24
DRAWN BY:	JULIA SKILLIN
CHECKED BY:	CAITLIN JACOBSON
APPROVED BY:	

Maseeh College of Engineering and Computer Science
PORTLAND STATE UNIVERSITY

CITY OF SALEM
MINTO-BROWN PARK BOARDWALK

CE 484 GROUP 8	GENERAL NOTES	REV A
SCALE: N/A	SHEET 2 OF 6	


1260 FT



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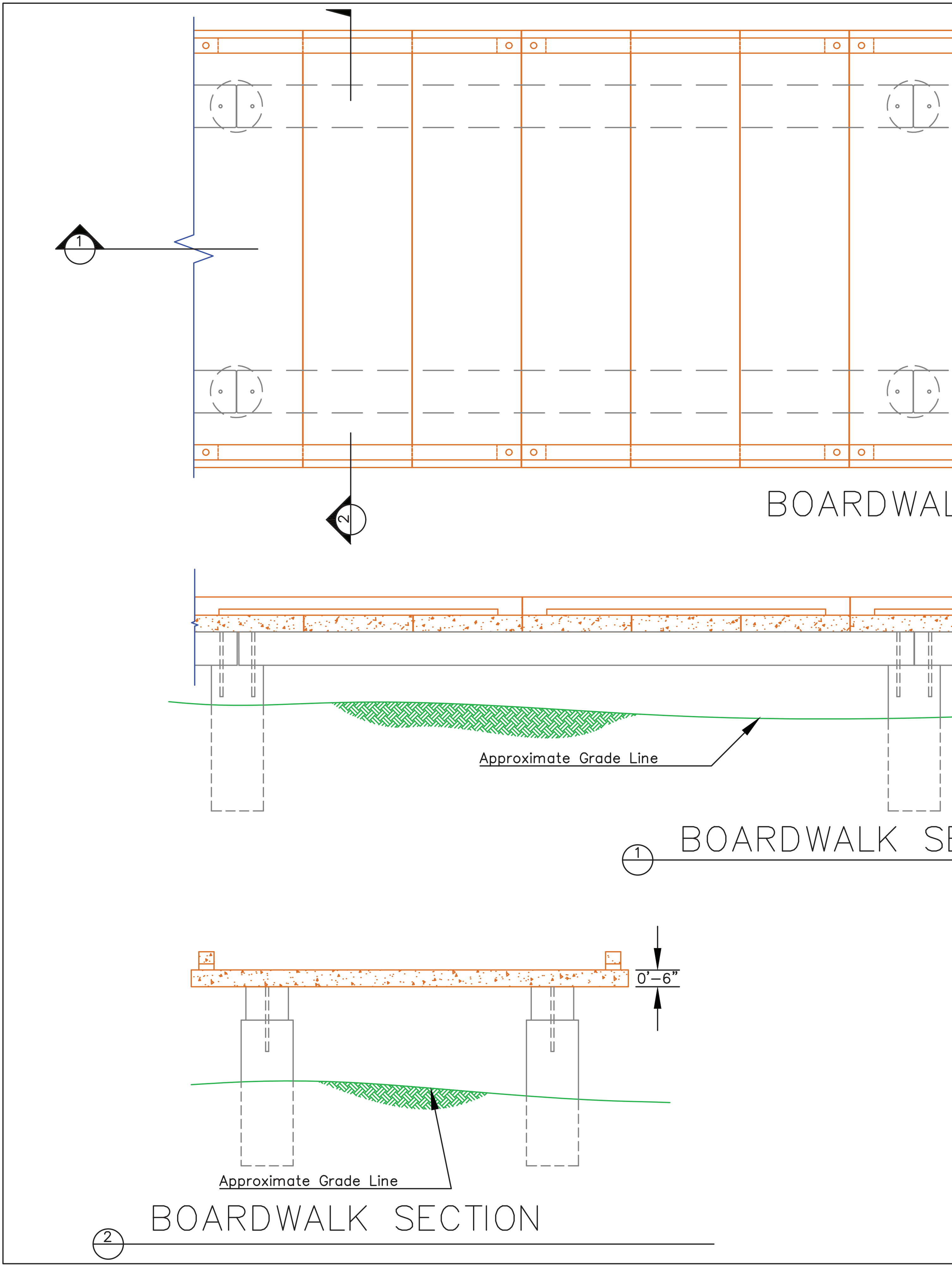
CITY OF SALEM
MINTO-BROWN PARK BOARDWALK

CE 484 GROUP 8	PLAN VIEW	REV A
SCALE: ~1":170'	SHEET 3 OF 6	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0'–6"
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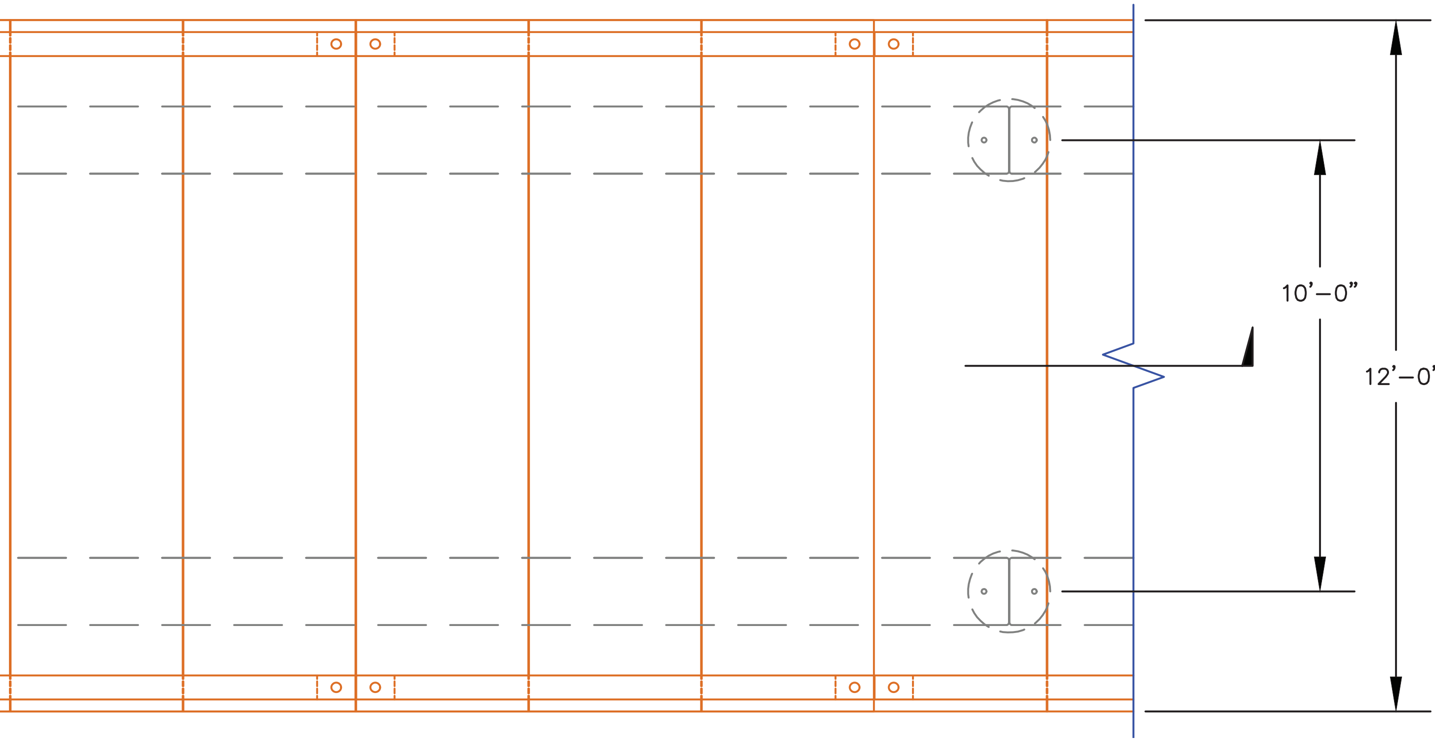
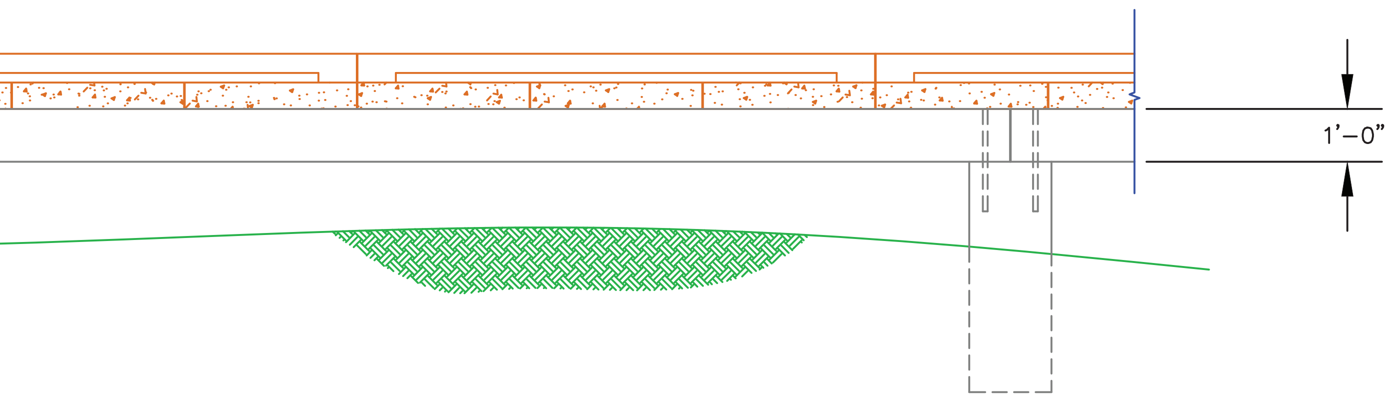
BOARDWALK SECTION
2



LK PLAN



ECTION

DATE:	6/9/24
DRAWN BY:	JULIA SKILLIN
CHECKED BY:	
APPROVED BY:	

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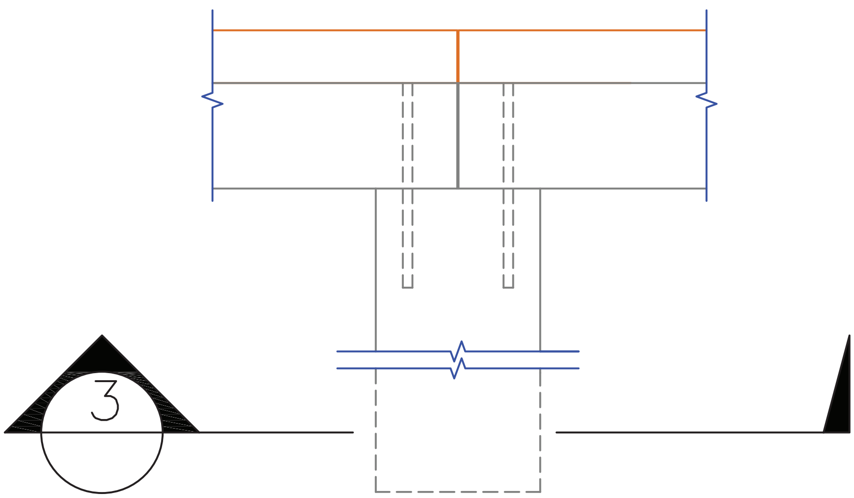
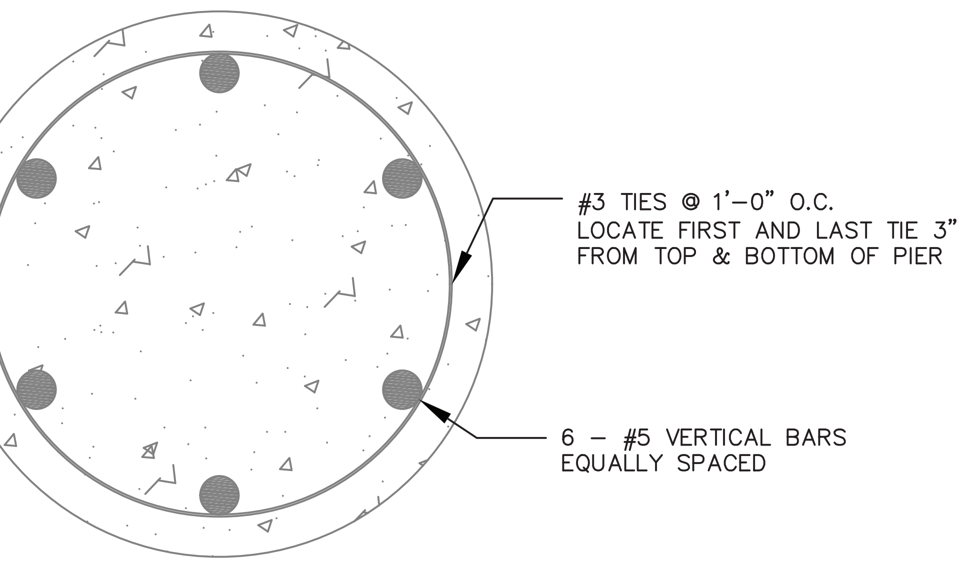
CITY OF SALEM
MINTO–BROWN PARK BOARDWALK

CE 484 GROUP 8	SECTIONS	REV A
SCALE: AS SHOWN	SHEET 4 OF 6	



TYPICAL PIER
CONNECTION
DETAIL



3 PIER SECTION

DATE:	6/9/24
DRAWN BY:	JULIA SKILLIN
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APPROVED BY:	

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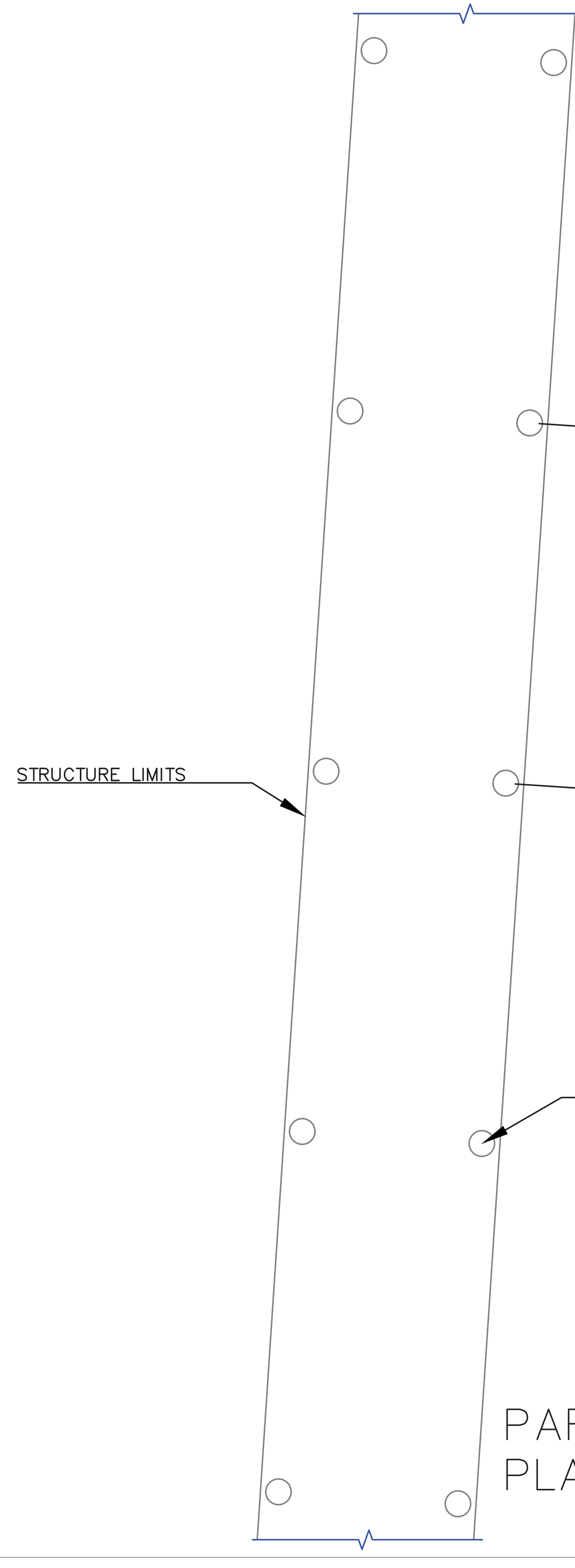
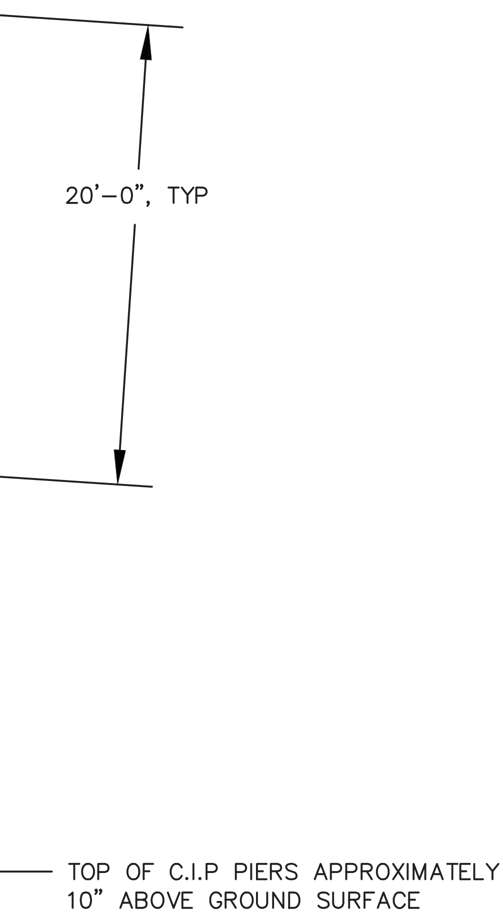
MINTO–BROWN PARK BOARDWALK

CE 484 GROUP 8	DETAILS	REV A
SCALE: AS SHOWN	SHEET 5 OF 6	



STRUCTURE LIMITS
PAR
PLA



RTIAL FOUNDATION
AN – TYPICAL LAYOUT

DATE:	6/9/24
DRAWN BY:	JULIA SKILLIN
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APPROVED BY:	

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MINTO–BROWN PARK BOARDWALK

CE 484 GROUP 8	FOUNDATIONS	REV A
SCALE: 1" : 100'	SHEET 6 OF 6	

Appendix B

Calculations

Calculations Table of Content

Appendix

<u>B.1: Spans</u>

B.1.1 On Ramp

Must be less than 5% (1:20) slope to eliminate the use of handrails (*ref*).

Expected elevation of structure, measured to the boardwalk surface: 1.5 ft

Ramp length: 1.5 ft *20 = 30 ft.

B.1.2: Prismatic Span Length

Ramps were calculated at 30 ft, for a total of 60 ft of the total span length (1260 ft).

Each span will be taken at 20 ft.

B.2: Tread Design

B.2.1: Dimensions, Cross Section

Slab	Notation	Value	Units	Notes
Length	L	12	ft	This length is the width of the boardwalk
Height	h	0.5	ft	Desired thickness, modify as needed
Width	b	4.0	ft	Into the page
Rebar	d	0.375	ft	Measured from the top of slab down
Rebar	d'	1.5	in	Measured from the bottom of the slab

These dimensions are assumed values and will change as necessary to meet strength requirements and code requirements.

Tread dimensions assuming 1 ft width with beams acting as supports.

B.2.2: Gravity Loads

Type	Name/user	Weight	Units	Notes
Dead	Self Weight	145	pcf	Spans for 6" in lateral direction, spans 6 ft in longitudinal direction
Live	Pedestrians	90	psf	Uniform
Snow	Snow	43	psf	Uniform, per ASCE Hazard Tool
Ice/rain	Ice/rain	5.79	psf	Negligible; will not control in combinations
Live	Vehicle (ATV)	1000	lbs	80% of weight to back wheels, 40% each

B.2.3: Lateral Loads

Type	Name/user	Weight	Note
Wind	Wind	-	Neglect per City of Salem request
Hydrostatic	Hydrostatic	-	N/A

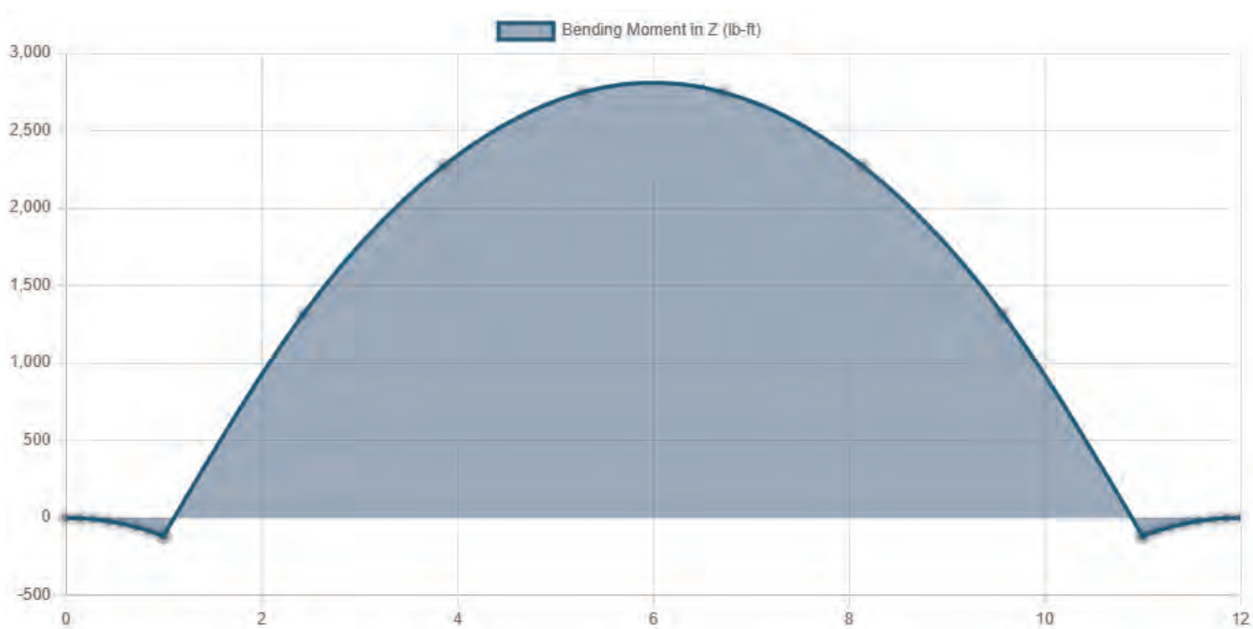
Permitted to ignore if requested by client/owner per AASHTO Chapter 3. Our clients allowed us to neglect these loads.

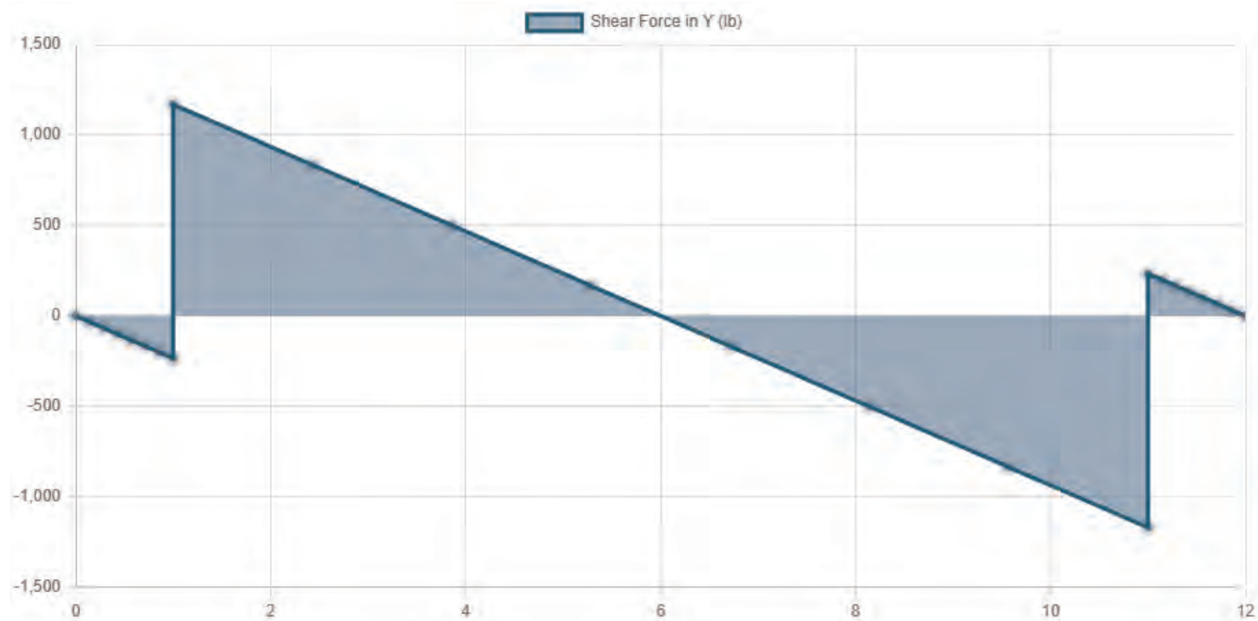
B.2.3: Factored Gravity Loads

Type	Notation	Load	Units	Notes
Dead	DL	348	plf	Multiply by 1.2
Live	LL	576	plf	Multiply by 1.6
Snow	SL	28	plf	Multiply by 0.5; maximum value controls in equation
Ice/rain	RL	11.58	plf	

B.2.3: Maximum Bending and Shear

Taking the pedestrian live load and self weight (dead load), the following diagrams were created. Note that the ATV live load was neglected in the following calculations due to lack of software availability and knowledge of specific codes.





From the diagrams, the maximums were taken as:

$M_u = M_{max} = 2748$ lb-ft
$V_u = V_{max} = 1170$ lb

B.2.4: Rebar Calculations

The following properties have been used thus far for the calculation of steel rebar:

Material Properties	Notation	Value	Units	Notes
Steel Modulus of Elasticity	Es	29000000	psi	
Yield Strength of Steel	fy	60000	psi	Assumed
Concrete Compressive Strength	f'c	4000	psi	Subject to change as needed

The iterative method was used to determine the minimum amount of steel required while also ensuring compliance with the minimum and maximum steel ratios (ρ). This method assumes a ___ , a, value to plug into the equation __ (code eq #) and plugging it into equation (code #) until the correct values become balanced. When the assumed a equates to that of the output, the As is taken as the required area of steel for the design. As stated, M_u = 2748 lb-ft, and Φ = 0.9 for tension. The calculations are as follows:

$A_s = M_u / [\Phi * f_y * (d - a/2)]$
$a = A_s*f_y / [0.85 * f'c * b)$

Try: a = 1.0 in
As = 0.1527 in^2
a = 0.2994 in

Try a = 0.2994
As = 0.1404
a = 0.2753

Try a = 0.2753
As = 0.1400
a = 0.2745

Try a = 0.2745
As = 0.1400
a = 0.2745

The required area of steel for reinforcement is therefore 0.14 in^2 per tread section. 3 #3 bars were chosen to meet this requirement, resulting in an As of 0.22 in^2.

The minimum reinforcement ratio, ρ_{min}, is 0.0033 and the maximum, ρ_{max}, is 0.181. Using the formula, ρ = As/(b*d) where b = 12" and d = 4.5", the ratio computed was 0.004. This value met the ratios and thus confirmed the 2 #3 bars are sufficient.

Rebar: 2 #3 at d = 4.5"

B.2.3: Design Moment Strength

Using the equation:

$$\Phi Mn = \Phi * As * fy * (d - a/2)$$
$$\Phi Mn = 0.9 * 0.22 * 60000 \text{ psi} * (4.5 \text{ in} - 0.2745 \text{ in}/2)$$
$$\Phi Mn = 51829 \text{ lb-in}$$
$$\Phi Mn = 4319 \text{ lb-ft}$$

The design of the treads has a moment strength that exceeds the bending moment of the load, Mu. In other words, Mu = 2.75 kip-ft < ΦMn = 4.32 kip-ft, meets the required strength.

B.2.3: Shear Strength Check

As stated, Vu = 1170 lbs. For a shear check, the designed shear strength of the concrete, ΦV_c, is assessed and must exceed that of Vu.

$\Phi V_c = 2\ \Phi\ \lambda \sqrt{(f'_c)} * bd$
$\Phi V_c = 6147.5$ lbs

$\underline{Vu < \Phi V_n}$

The design has a shear strength that is adequate for the maximum shear load of 1170 lbs.

Additionally, shear load is checked at a distance of 4.5 in. due to d = 4.5 in. This is to ensure that the design strength at this point is still capable of resisting the acting loads by using the formula: φ/2 * Vc.

When applying this check, Vu (@d = 4.5) = 88 lbs, and φ/2 * Vc = 3073.7lbs.

Doing both checks, the shear strength of the design is adequate in order to resist the expected loads. No stirrups are required.

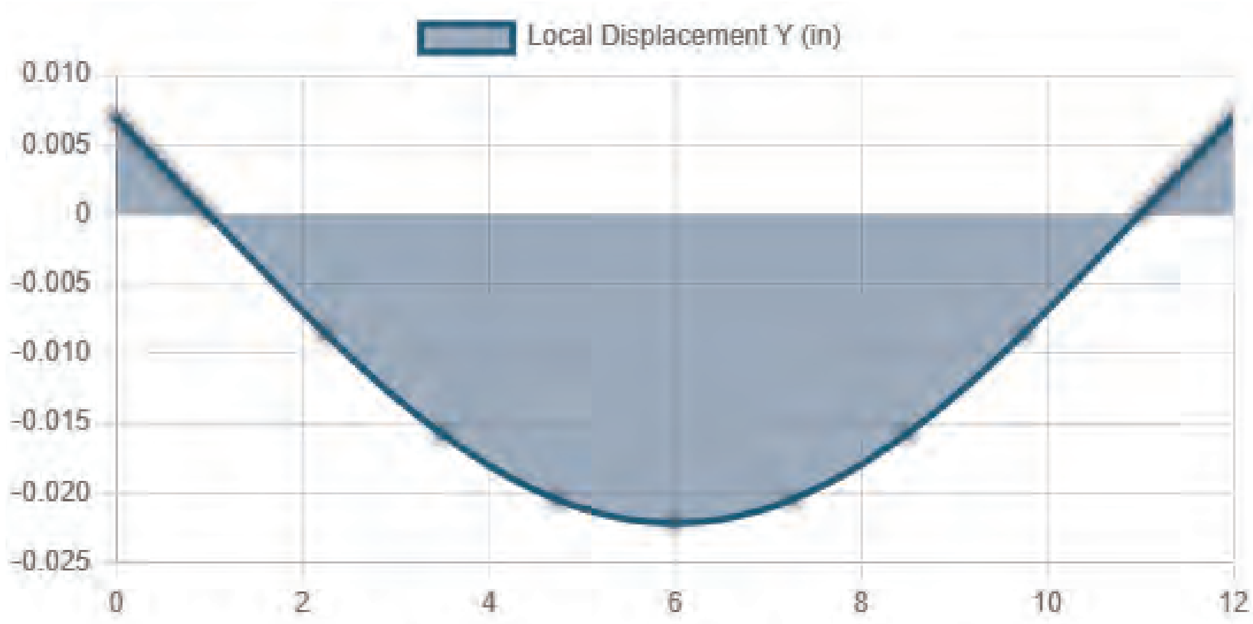
B.2.3: Deflection

The deflection of the treads was calculated to comply with AASHTO's pedestrian bridges limit. These limits of the deflection of the bridge are calculated based on the unfactored pedestrian live load. For the supported span, it shall not exceed 1/360 of the span length. For the cantilever ends, must not exceed l/220.

Supported span:
Length = 10 ft = 120 in
$\Delta_{allowable} = 120/360 = 0.333$

Cantilever span:
Length = 1 ft = 12 in
$\Delta_{allowable} = 12/220 = 0.055$ in

A simple analysis was done using the unfactored pedestrian load of 90 plf. That resulted in the diagram below. In this resulting diagram, the deflection at the cantilever ends is 0.007 in and is 0.022 in for the center span. Both of these fall below the allowable deflection and is therefor satisfactory for compliance.

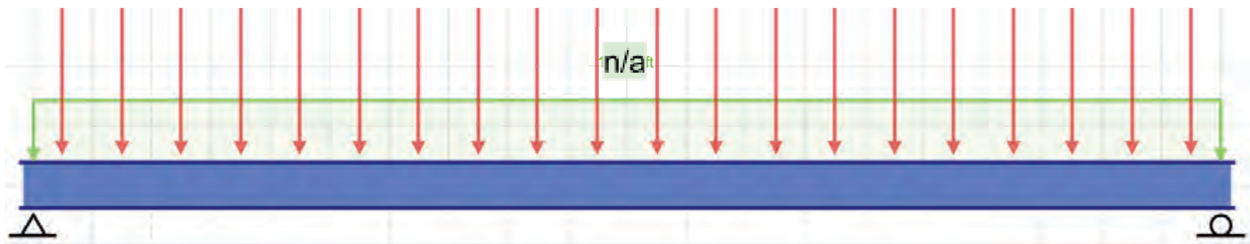


Deflection due to unfactored pedestrian load.

B.3: Beam Design

B.3.1: Beam Section

The beams supporting the treads will have a length of 20 ft. Each beam will support 20 1-ft wide treads as designed above and will be placed 6 in. from the edge of the beam. Below is an image showing the general load that is being designed for where each red arrow is the load being transferred from the tread sections (live load and dead load). The green uniform load represents the beam's self-weight which will be determined after the beam's width and depth are determined.



Solving for the beam dimensions while simultaneously solving for the steel ratio requirements, described B.3.4, the resulting beam will have a width of 12 in. and height of 14 in.

B.3.2: Gravity Loads

Type	Name/user	Weight	Units	Notes
Dead	Self Weight	150	pcf	Spans for 6" in lateral direction, spans 6 ft in longitudinal direction
Dead/Live	Treads	1404	lbs	The load being transferred from the treads. Treated as point loads.

B.3.3: Lateral Loads

There are no lateral loads to consider per client recommendation.

B.3.4: Setting Dimensions and Steal Requirements

Since there are no known dimensions with the expected loads and length being the known values, reinforcement ratios were looked at. For 4000 psi concrete and Grade 60 steel, $\rho_{min} = 0.0033$ and $\rho_{max} = 0.0181$. Additionally, the maximum moment being caused by the loading of the treads alone is known and is M1 = 70.2 kip-ft. This was found by creating a shear diagram and taking the area to create the moment diagram,

A spreadsheet was used to attempt to find a ratio that satisfies the minimum and maximum while simultaneously solving for the beam weight. In other words, iterations were used. The formulas used are listed in the table as well. To simplify calculating the required steel, an assumed width, b, of 1 ft was used. The depth at which rebar will be placed was set to be 3 in. from the edge of the tension face.

Property	Value	Unit	Formula
L =	20	ft	-
f'c =	4000	psi	-
fy =	60000	psi	-
concrete wt =	150	pcf	-
b =	12	in	*Assumed*
h =	14	in	*Trial and error*
d =	11	in	h - 3"
beam wt =	175	plf	150 pcf * b *d
wu =	210	plf	1.2 * bm wt
M1 =	70200	lb-ft	*From treads*
M2 =	10500	lb-ft	$wuL^2/8$
Mu =	80700	lb-ft	M1 + M2
Rn =	741		Mu/φbd2
ρmin =	0.0033		-
ρmax =	0.0181		-
ρ =	0.0141		(0.85*f'c/fy) * (1 -√[1 - 2* Rn/(0.85*f'c)])
Does steel ratio satisfy the requirement?			***YES***

Using this iterative method, the beam will be set to be 12 in. wide and have a height of 14 in. The depth of the rebar will be 11 in. from the compression face.

B.3.5: Rebar

The reinforcement ratio set forth by the method above is 0.0141. This can then be set to solve for an approximate area of steel required to satisfy the ratios. Using the formula, ρ = As/(bd), an estimate of how much steel is needed can be obtained.

$As_{estimate} = \rho*bd = 0.0141*12 \text{ in.} *11 \text{ in.} = 1.86 \text{ in}^2$

Rebar sizes and the number of bars can be plugged in to equate this estimate. Using 3 #8 bars has an area of steel of 2.37 in^2. Ensure it still complies with the minimum and maximum.

$\rho = 2.36 \text{ in}^2/(12 \text{ in} * 11 \text{ in}) = 0.0179$
$\rho_{min} = 0.0033 < \rho = 0.0179 < \rho_{max} = 0.0181$. Ratio satisfies requirements.

Beam rebar: 3 #7 @ d = 11 in

B.3.6: Moment Strength Check

The maximum bending moment, Mu, was previously calculated in B.3.4 at 80.7 kip-ft. The design bending strength is calculated using the formula, ΦMn = Φ[As*fy*(d-a/2)).

- a = As * fy /(0.85*f'c*b)
- a = 2.37 * 6000 psi /(0.85 * 4000 psi * 12 in.)
- a = 3.49

- ΦMn = 2.37 * 60000 psi * [11 in. – (3.49 in. / 2)]
- ΦMn = 98730 lb-ft

The strength of the beam design is adequate to resist that of the acting loads.

<u>Mu = 80.7 kip-ft < ΦMn = 98.7 kip-ft</u>

B.3.7: Shear Strength Check

To determine if stirrups are required, the shear load at a distance of 11 in. must be calculated. If Vu is greater than half of the design shear strength, stirrups must be used.

Vu (@ d = 11 in.) = 12828.5 lbs.

$\Phi V_c = 2\ \Phi\ \lambda \sqrt{(f'_c)} * bd$
$\Phi V_c = 12522.6$ lbs

$\Phi V_c /2 = 6261.3$ lbs.

<u>Vu > ½ ΦV_C ∴ Stirrups are required.</u>

B.3.8: Stirrup

#3 stirrups were selected with a spacing, s = d/2 = 5.5 in.

B.3.9: Deflection

The deflection of the beam was not calculated given the confusion regarding various deflection limits from various different codes. It is to be further analyzed. The columns are designed on the assumption that the deflection limits are satisfied.

B.4: Column Design

B.4.1: Dimensions, Cross Section

B.4.1: Gravity Loads

B.4.1: Lateral Loads

B.4.1: Factored Gravity Loads

B.4.1: Rebar Calculations

B.4.1: Moment Strength Check

B.4.1: Buckling Check

B.4.1: Shear Strength Check

B.4.1: Deflection

Columnas were not designed due to time.

Appendix

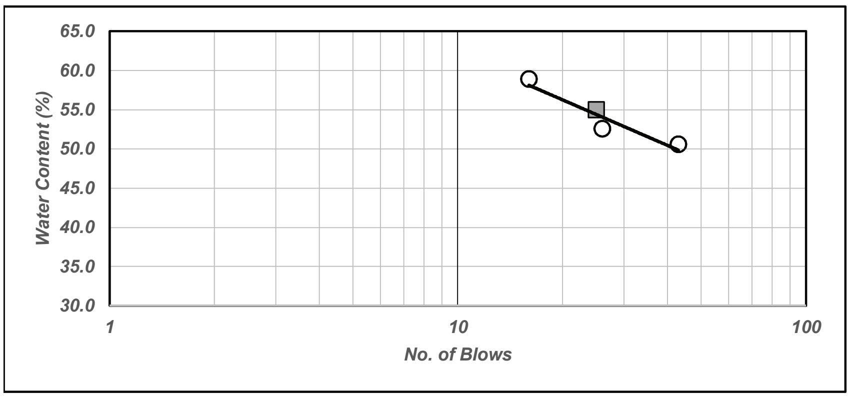
Appendix C
Soil Testing

Project:	Minto-Brown	Test Name:	Boardwalk	Date Collected:	3/8/2024
Location:				Date Tested:	3/12/2024

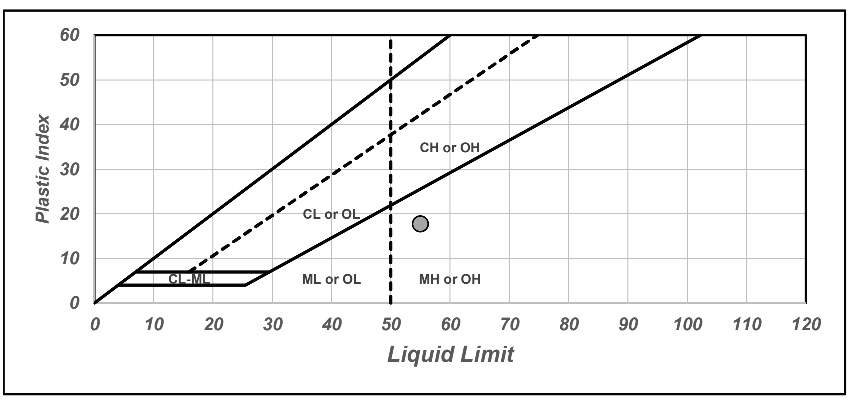
Borehole:	HA-01	Sample Number:	1	Depth (ft-ft):	1.5	2.0	Average Depth (ft):	1.75

Liquid Limit						Plastic Limit				
Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)	No. of Blows	Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)
w_n	15.7	10.7	5	46.7		1	10.2	7.5	2.7	36.0
1	14.3	9	5.3	58.9	16	2	10.8	7.8	3	38.5
2	11.9	7.8	4.1	52.6	26					
3	12.8	8.5	4.3	50.59	43					

Liquid Limit: 55
Plastic Limit: 37
Plasticity Index: 18



Total amount of materials passing sieve No. 40: 100 %



Fines Classification: MH

Procedure Done By Caitlin Jacobson

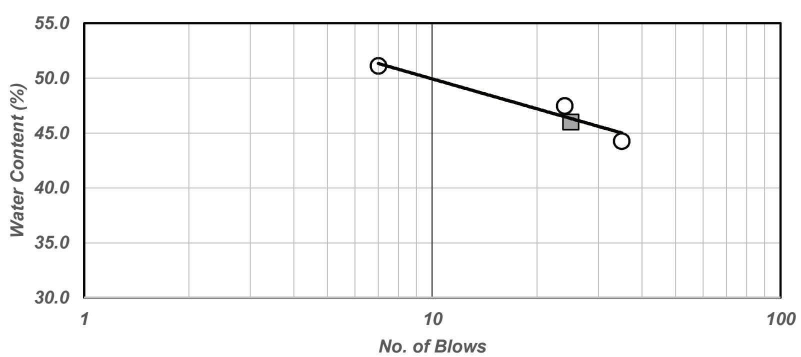
Portland State UNIVERSITY

Project: Minto-Brown	Test Name: Boardwalk	Date Collected: 3/8/2024
Location:		Date Tested: 3/12/2024

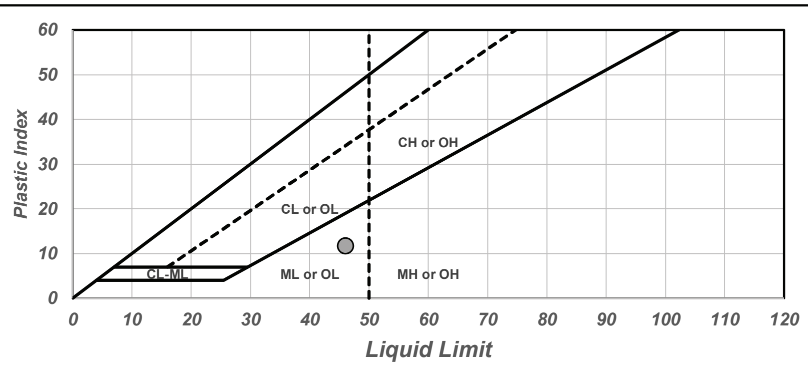
Borehole: HA-01	Sample Number: 1	Depth (ft-ft): 2.5 3.0	Average Depth (ft): 2.75

Liquid Limit						Plastic Limit				
Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)	No. of Blows	Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)
w_n	36.3	24.9	11.4	45.8		1	12.6	9.4	3.2	34.0
1	33.9	23.5	10.4	44.3	35	2	11.3	8.4	2.9	34.5
2	29.2	19.8	9.4	47.5	24					
3	13.6	9	4.6	51.11	7					

Liquid Limit: 46
Plastic Limit: 34
Plasticity Index: 12



Total amount of materials passing sieve No. 40: 100 %



Fines Classification: ML

Procedure Done By Scott Allan

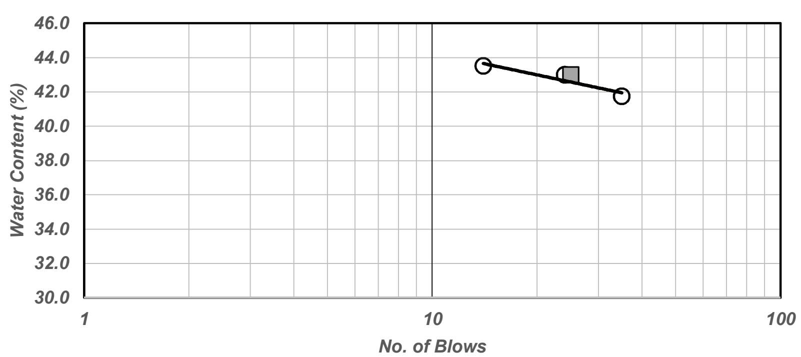
Portland State UNIVERSITY

Project: Minto-Brown	Test Name: Boardwalk	Date Collected: 3/8/2024
Location:		Date Tested: 3/12/2024

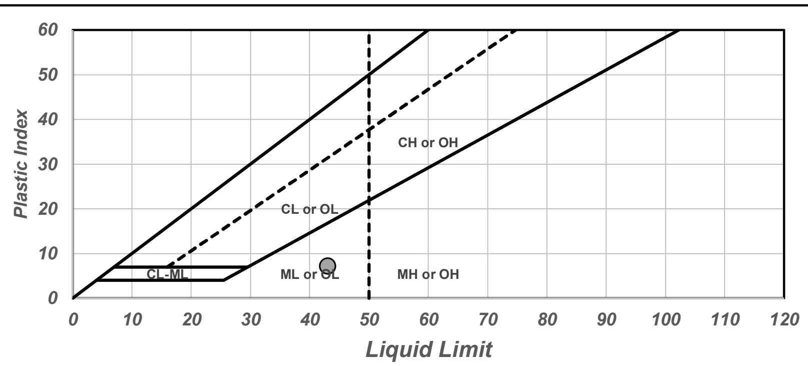
Borehole: HA-01	Sample Number: 1	Depth (ft-ft): 3.5 4.0	Average Depth (ft): 3.75

Liquid Limit						Plastic Limit				
Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)	No. of Blows	Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)
w_n	41.9	29.1	12.8	44.0		1	12.9	9.5	3.4	35.8
1	31	21.6	9.4	43.5	14	2	14.8	10.9	3.9	35.8
2	29.6	20.7	8.9	43.0	24					
3	29.2	20.6	8.6	41.75	35					

Liquid Limit: 43
Plastic Limit: 36
Plasticity Index: 7



Total amount of materials passing sieve No. 40: 100 %



Fines Classification: ML

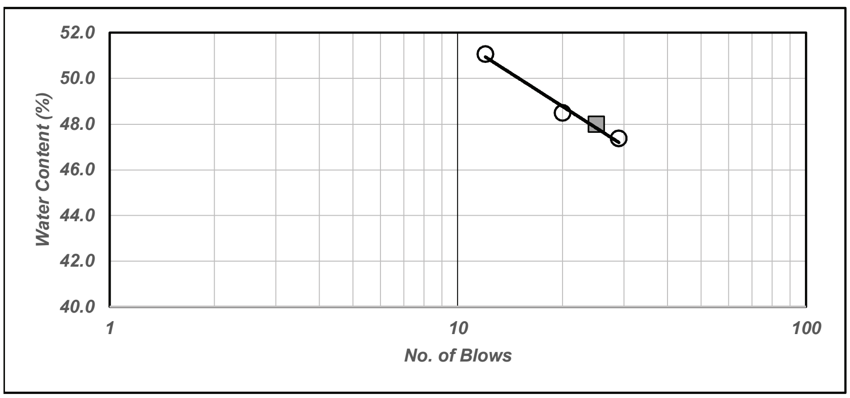
Procedure Done By Scott Allan

Portland State UNIVERSITY

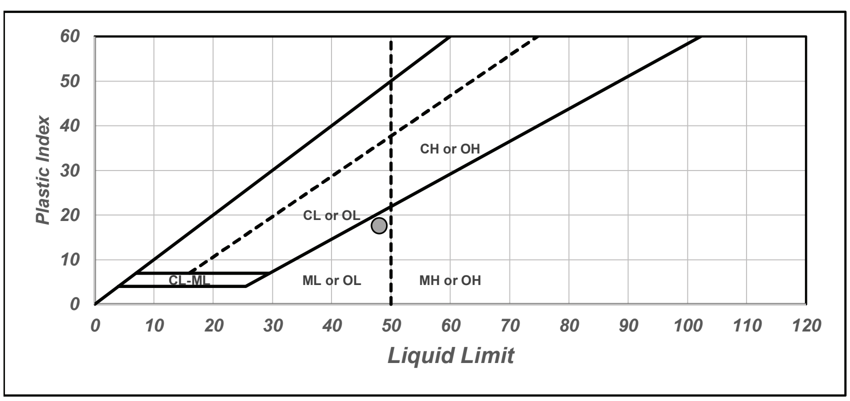
Project: Minto-Brown		Test Name: Boardwalk		Date Collected: 3/8/2024	
Location:				Date Tested: 3/12/2024	
Borehole: HA-02	Sample Number: 1		Depth (ft-ft): 1.5 2.0	Average Depth (ft): 1.75	

Liquid Limit						Plastic Limit				
Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)	No. of Blows	Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)
w_n	16.4	12.4	4	32.3		1	9.6	7.3	2.3	31.5
1	11.2	7.6	3.6	47.4	29	2	9.3	7.2	2.1	29.2
2	9.8	6.6	3.2	48.5	20					
3	14.2	9.4	4.8	51.06	12					

Liquid Limit: 48
Plastic Limit: 30
Plasticity Index: 18



Total amount of materials passing sieve No. 40: 100 %



Fines Classification: ML

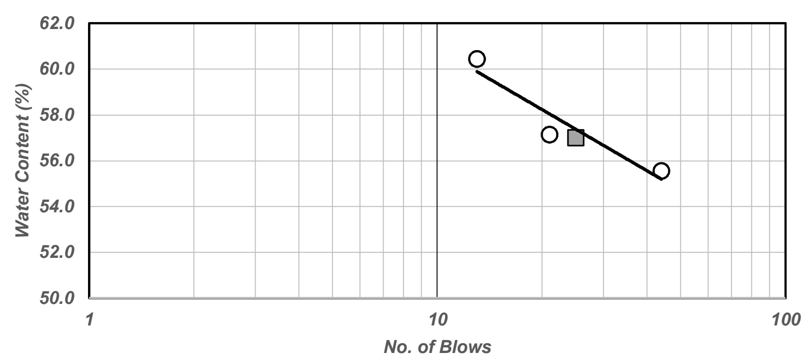
Procedure Done By Caitlin Jacobson

Project:	Minto-Brown	Test Name:	Boardwalk	Date Collected:	3/8/2024
Location:				Date Tested:	3/12/2024

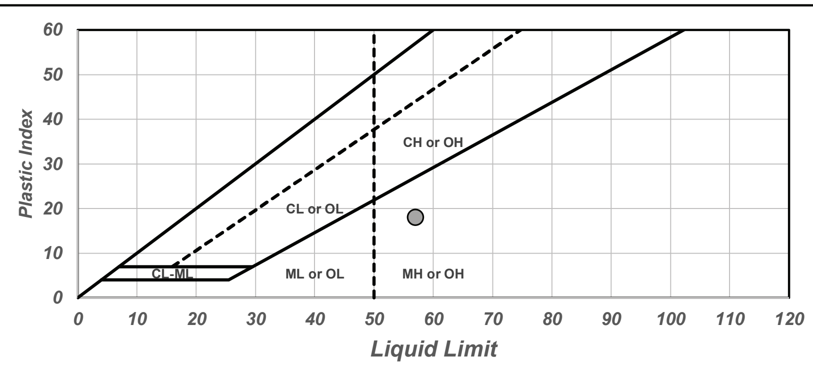
Borehole:	HA-02	Sample Number:	1	Depth (ft-ft):	2.5	3.0	Average Depth (ft):	2.75

Liquid Limit						Plastic Limit				
Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)	No. of Blows	Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)
w_n	16.9	11.7	5.2	44.4		1	9.5	6.8	2.7	39.7
1	15.4	9.9	5.5	55.6	44	2	10.5	7.6	2.9	38.2
2	11	7	4	57.1	21					
3	14.6	9.1	5.5	60.4	13					

Liquid Limit: 57
Plastic Limit: 39
Plasticity Index: 18



Total amount of materials passing sieve No. 40: 100 %



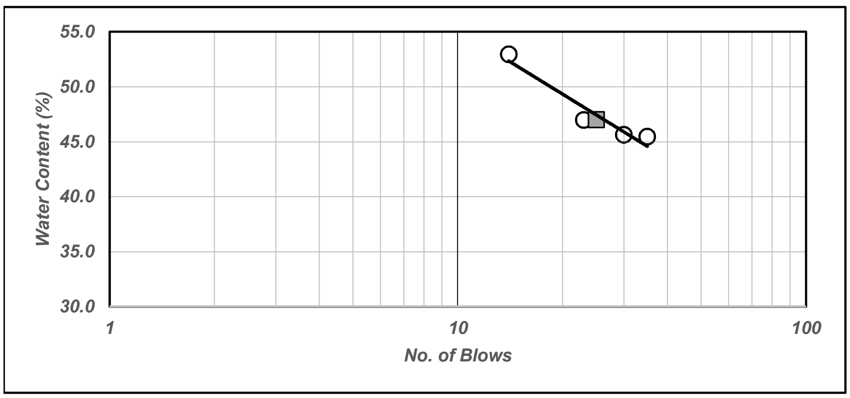
Fines Classification: MH

Procedure Done By Caitlin Jacobson

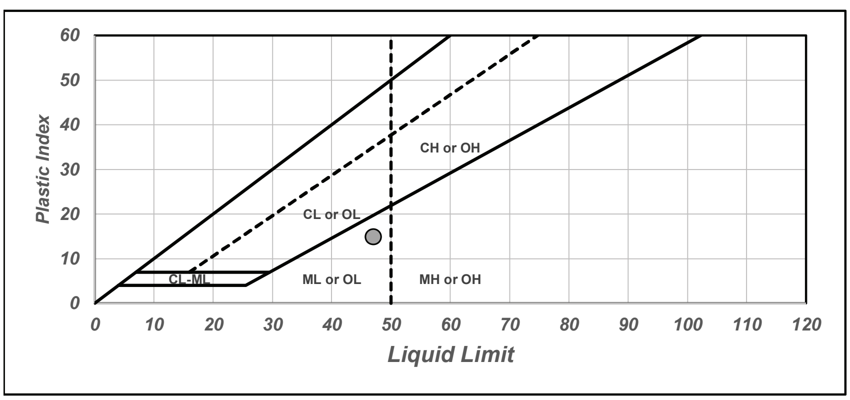
Project:	Minto-Brown	Test Name:	Boardwalk	Date Collected:	3/8/2024
Location:				Date Tested:	3/12/2024
Borehole:	HA-02	Sample Number:	1	Depth (ft-ft): 3.5 4.0	Average Depth (ft): 3.75

Liquid Limit						Plastic Limit				
Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)	No. of Blows	Sample Number	Weight of Wet Soil (g)	Weight of Dry Soil (g)	Weight of Water (g)	Water Content (%)
w_n	19.2	13	6.2	47.7		1	13	9.9	3.1	31.3
1	15	10.3	4.7	45.6	30	2	9.3	7	2.3	32.9
2	10.4	6.8	3.6	52.9	14					
3	9.6	6.6	3	45.45	35					
4	9.7	6.6	3.1	46.97	23					

Liquid Limit: 47
Plastic Limit: 32
Plasticity Index: 15



Total amount of materials passing sieve No. 40: 100 %



Fines Classification: ML

Procedure Done By Caitlin Jacobson

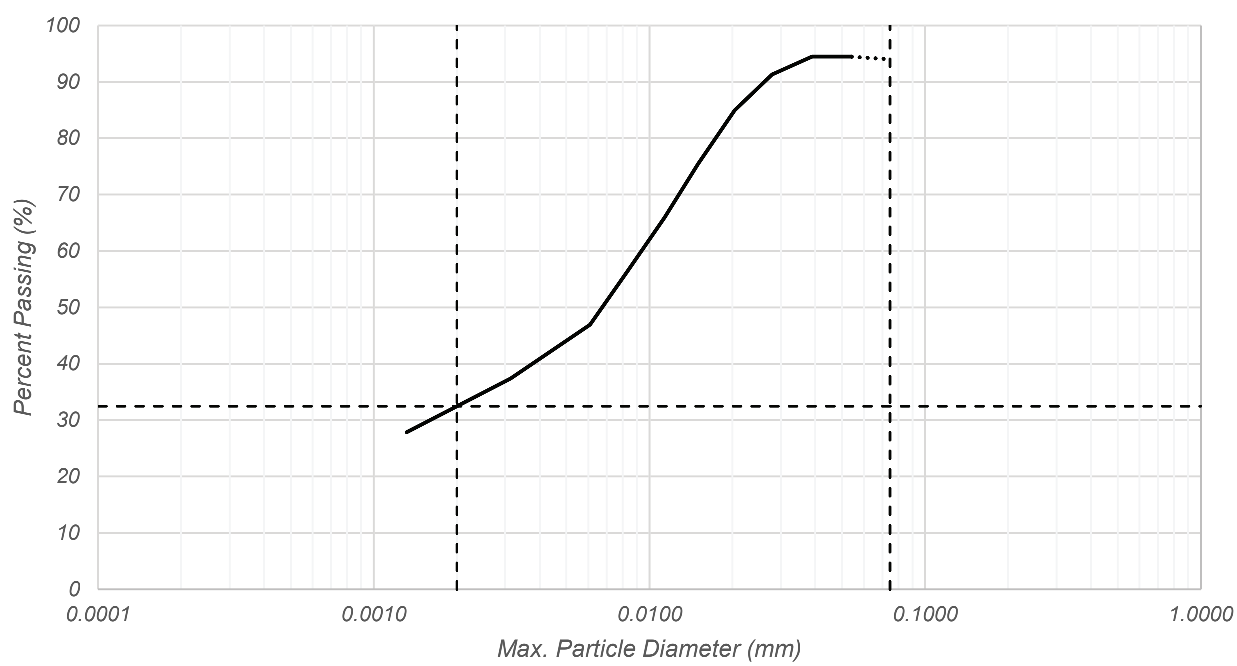
Portland State UNIVERSITY

Hydrometer Test

Date Tested: March 14, 2024

Project:	Minto-Brown	**Assumed Gs:**	2.7	**Beg. Depth (ft):**	1.5
Boring:	HA-01	**Dry Mass (g):**	50.0	**End Depth (ft):**	2
Sample:	1	**Hydrometer:**	151H	**Ave. Depth (ft):**	1.75

Time (min)	Temp (°C)	Hydrometer Readings		Corrections			Max. Particle Diameter (mm)	Percent Passing (%)
		Control	Slurry	Temperature	Hydrometer	Effective Depth		
0.5	20.0	1.003	1.031	0.01365	1.028	8.1	0.054095	94.48
1	20	1.002	1.030	0.01365	1.028	8.4	0.038953	94.48
2	20	1.002	1.029	0.01365	1.027	8.6	0.027870	91.31
4	20	1.002	1.027	0.01365	1.025	9.2	0.020383	84.97
8	20	1.002	1.024	0.01365	1.022	10.0	0.015026	75.45
15	20	1.002	1.021	0.01365	1.019	10.7	0.011351	65.94
30	19.9	1.002	1.018	0.01367	1.016	11.5	0.008321	56.42
60	20.1	1.002	1.015	0.01363	1.013	12.3	0.006085	46.91
240	20.3	1.002	1.012	0.01360	1.010	13.1	0.003140	37.39
1454	20.2	1.002	1.009	0.01362	1.007	13.9	0.001314	27.88



P200 Wash

Date Tested:	March 14, 2024				
Container ID:	B03			**Soil Breakdown**	
Container Tare (g):	136.9			Coarse [%]:	6.00
Dry Mass Before + Tare (g)	N/A	Dry Mass Before (g):	50.0	Fines Fraction [%]:	94.00
Dry Mass After + Tare (g)	139.9	Dry Mass After (g):	3.0	Silts [%]:	61.50
				Clays [%]:	32.50

Hydrometer Done By: Caitlin Jacobson

Wash Done By: Caitlin Jacobson

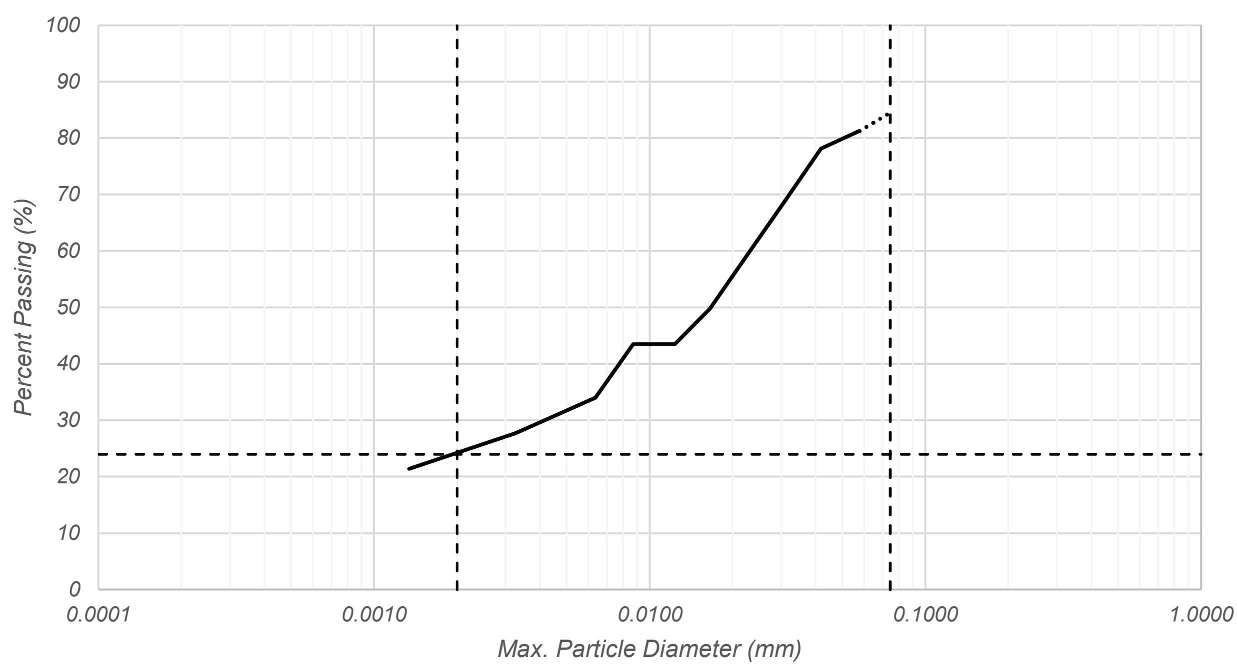
Portland State University

Hydrometer Test

Date Tested: March 14, 2024

Project:	Minto-Brown		**Assumed Gs:**	2.7		**Beg. Depth (ft):**	2.5
Boring:	HA-01		**Dry Mass (g):**	50.3		**End Depth (ft):**	3
Sample:	2		**Hydrometer:**	151H		**Ave. Depth (ft):**	2.75

Time (min)	Temp (°C)	Hydrometer Readings		Corrections			Max. Particle Diameter (mm)	Percent Passing (%)
		Control	Slurry	Temperature	Hydrometer	Effective Depth		
0.5	20.1	1.003	1.027	0.01363	1.024	9.2	0.057651	81.27
1	20.1	1.002	1.025	0.01363	1.023	9.7	0.041859	78.12
2	20.1	1.002	1.022	0.01363	1.020	10.5	0.030795	68.66
4	20.1	1.002	1.019	0.01363	1.017	11.3	0.022590	59.21
8	20.1	1.002	1.016	0.01363	1.014	12.1	0.016529	49.76
15	20.1	1.002	1.014	0.01363	1.012	12.6	0.012318	43.45
30	20.1	1.002	1.014	0.01363	1.012	12.6	0.008710	43.45
60	20.3	1.002	1.011	0.01360	1.009	13.4	0.006351	34.00
237	20.4	1.002	1.009	0.01358	1.007	13.9	0.003255	27.70
1450	20.2	1.002	1.007	0.01362	1.005	14.4	0.001339	21.40



P200 Wash

Date Tested:	March 14, 2024		
Container ID:	B03		
Container Tare (g):	135.7		
Dry Mass Before + Tare (g)	N/A	Dry Mass Before (g):	50.3
Dry Mass After + Tare (g)	143.5	Dry Mass After (g):	7.8

Soil Breakdown

Coarse [%]:	15.49
Fines Fraction [%]:	84.51
Silts [%]:	60.51
Clays [%]:	24.00

Hydrometer Done By:	Caitlin Jacobson
Wash Done By:	Caitlin Jacobson

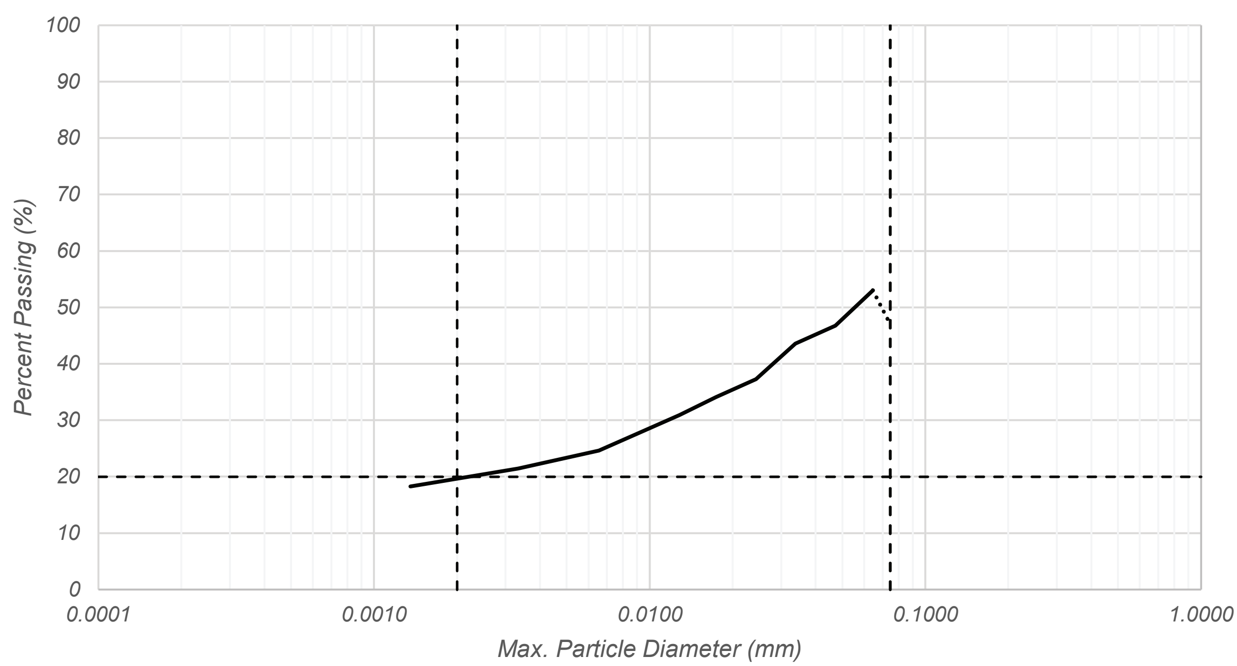
Portland State University

Hydrometer Test

Date Tested: March 14, 2024

Project:	Minto-Brown	**Assumed Gs:**	2.7	**Beg. Depth (ft):**	3.5
Boring:	HA-01	**Dry Mass (g):**	50.2	**End Depth (ft):**	4
Sample:	3	**Hydrometer:**	151H	**Ave. Depth (ft):**	3.75

Time (min)	Temp (°C)	Hydrometer Readings		Corrections			Max. Particle Diameter (mm)	Percent Passing (%)
		Control	Slurry	Temperature	Hydrometer	Effective Depth		
0.5	19.9	1.003	1.018	0.01367	1.015	11.5	0.064456	53.05
1	19.9	1.002	1.015	0.01367	1.013	12.3	0.047136	46.73
2	19.9	1.002	1.014	0.01367	1.012	12.6	0.033734	43.57
4	19.9	1.002	1.012	0.01367	1.010	13.1	0.024322	37.25
8	19.9	1.002	1.011	0.01367	1.009	13.4	0.017394	34.09
15	19.9	1.002	1.010	0.01367	1.008	13.7	0.012844	30.93
30	20.1	1.002	1.009	0.01363	1.007	13.9	0.009148	27.77
60	20.1	1.002	1.008	0.01363	1.006	14.2	0.006538	24.61
234	20.3	1.002	1.007	0.013616	1.005	14.4	0.003334	21.45
1446	20.2	1.002	1.006	0.013599	1.004	14.7	0.001355	18.29



P200 Wash

Date Tested:	March 14, 2024		
Container ID:	B03		
Container Tare (g):	136.5		
Dry Mass Before + Tare (g)	N/A	Dry Mass Before (g):	50.2
Dry Mass After + Tare (g)	163.1	Dry Mass After (g):	26.6

Soil Breakdown

Coarse [%]:	52.97
Fines Fraction [%]:	47.03
Silts [%]:	27.03
Clays [%]:	20.00

Hydrometer Done By:	Caitlin Jacobson
Wash Done By:	Caitlin Jacobson

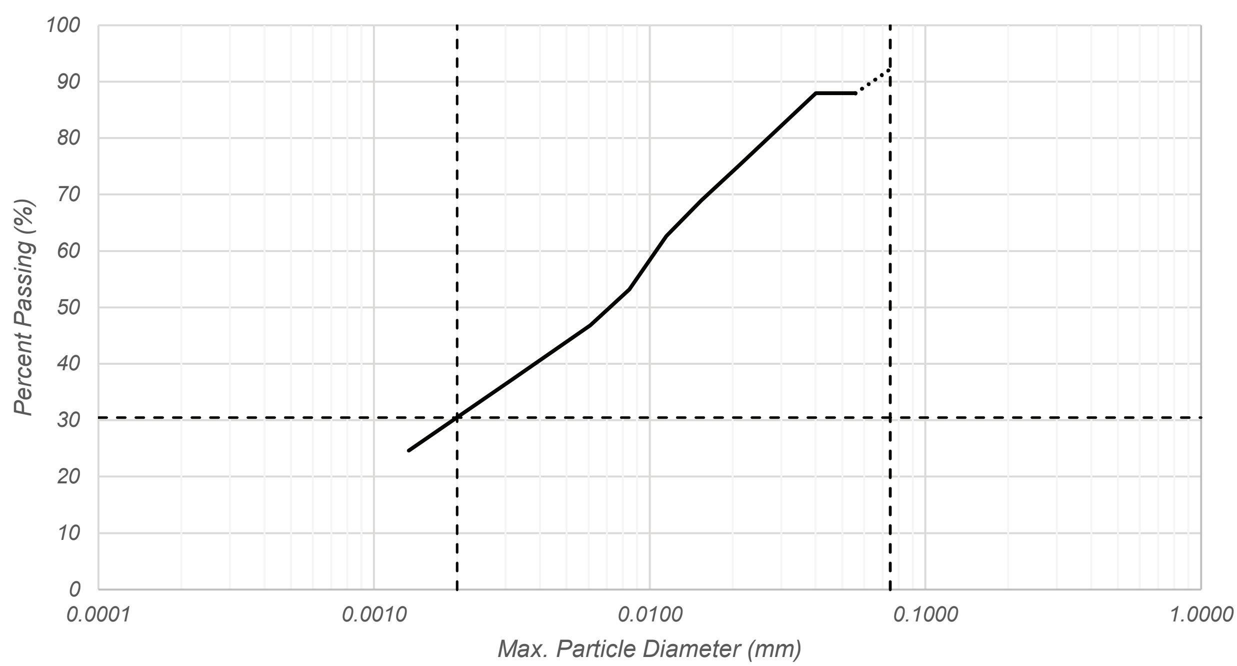
Portland State UNIVERSITY

Hydrometer Test

Date Tested: March 14, 2024

Project:	Minto-Brown	**Assumed Gs:**	2.7	**Beg. Depth (ft):**	1.5		
Boring:	HA-02	**Dry Mass (g):**	50.1	**End Depth (ft):**	2		
Sample:	1	**Hydrometer:**	151H	**Ave. Depth (ft):**	1.75		

Time (min)	Temp (°C)	Hydrometer Readings		Corrections			Max. Particle Diameter (mm)	Percent Passing (%)
		Control	Slurry	Temperature	Hydrometer	Effective Depth		
0.5	20.0	1.003	1.029	0.01365	1.026	8.6	0.055740	87.95
1	20.0	1.002	1.028	0.01365	1.026	8.9	0.040095	87.95
2	20.0	1.002	1.026	0.01365	1.024	9.4	0.029137	81.62
4	20.0	1.002	1.024	0.01365	1.022	10.0	0.021251	75.29
8	20.0	1.002	1.022	0.01365	1.020	10.5	0.015397	68.96
15	20.0	1.002	1.020	0.01365	1.018	11.0	0.011509	62.63
30	20.1	1.002	1.017	0.01363	1.015	11.8	0.008429	53.14
60	20.1	1.002	1.015	0.01363	1.013	12.3	0.006085	46.81
231	20.2	1.002	1.012	0.01362	1.010	13.1	0.003201	37.31
1441	20.1	1.002	1.008	0.01363	1.006	14.2	0.001334	24.65



P200 Wash

Date Tested:	March 14, 2024		
Container ID:	B03		
Container Tare (g):	135.4		
Dry Mass Before + Tare (g)	N/A	Dry Mass Before (g):	50.1
Dry Mass After + Tare (g)	139.3	Dry Mass After (g):	3.9

Soil Breakdown

Coarse [%]:	7.78
Fines Fraction [%]:	92.22
Silts [%]:	61.72
Clays [%]:	30.50

Hydrometer Done By:	Caitlin Jacobson
Wash Done By:	Caitlin Jacobson

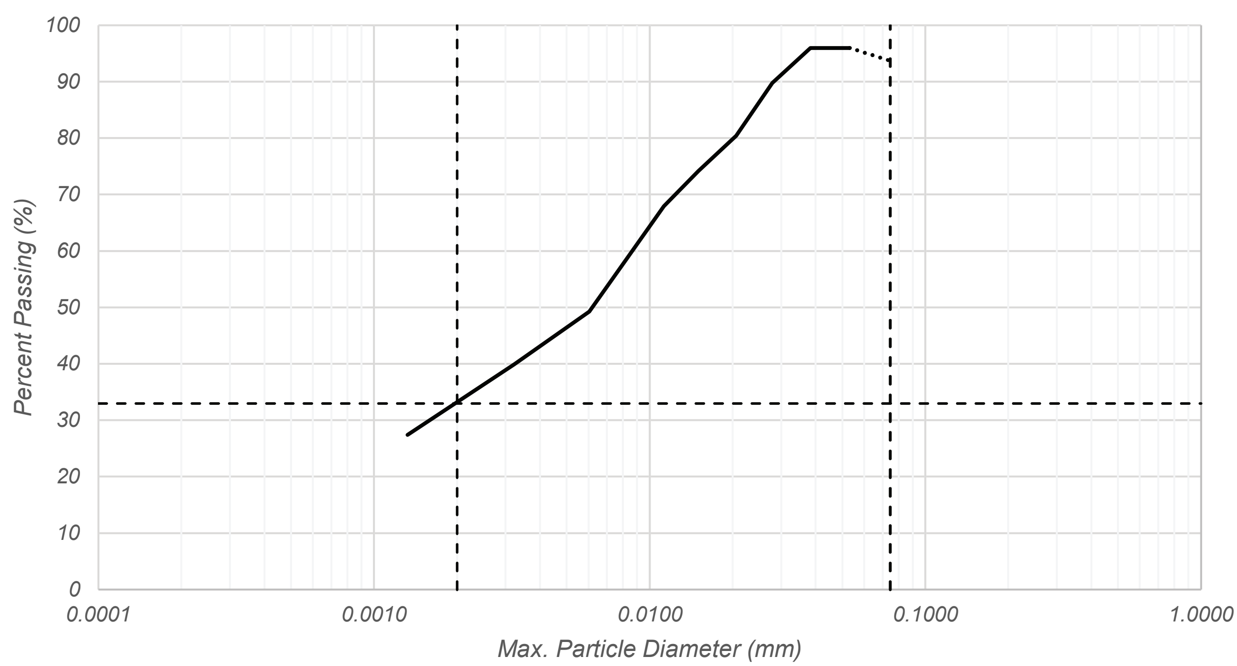
Portland State University

Hydrometer Test

Date Tested: March 14, 2024

Project:	Minto-Brown	**Assumed Gs:**	2.7	**Beg. Depth (ft):**	2.5
Boring:	HA-02	**Dry Mass (g):**	50.9	**End Depth (ft):**	3
Sample:	2	**Hydrometer:**	151H	**Ave. Depth (ft):**	2.75

Time (min)	Temp (°C)	Hydrometer Readings		Corrections			Max. Particle Diameter (mm)	Percent Passing (%)
		Control	Slurry	Temperature	Hydrometer	Effective Depth		
0.5	19.9	1.003	1.032	0.01367	1.029	7.8	0.053084	96.00
1	19.9	1.002	1.031	0.01367	1.029	8.1	0.038251	96.00
2	19.9	1.002	1.029	0.01367	1.027	8.6	0.027870	89.77
4	19.9	1.002	1.026	0.01367	1.024	9.4	0.020603	80.41
8	19.9	1.002	1.024	0.01367	1.022	10.0	0.015026	74.18
15	19.9	1.002	1.022	0.01367	1.020	10.5	0.011245	67.94
30	20.1	1.002	1.019	0.01363	1.017	11.3	0.008249	58.59
60	20.2	1.002	1.016	0.01362	1.014	12.1	0.006036	49.23
225	20.2	1.002	1.013	0.01362	1.011	12.9	0.003218	39.88
1437	20.1	1.002	1.009	0.01363	1.007	13.9	0.001322	27.41



P200 Wash

Date Tested:	March 14, 2024				
Container ID:	A3			Soil Breakdown	
Container Tare (g):	138.7			Coarse [%]:	6.29
Dry Mass Before + Tare (g)	N/A	Dry Mass Before (g):	50.9	Fines Fraction [%]:	93.71
Dry Mass After + Tare (g)	141.9	Dry Mass After (g):	3.2	Silts [%]:	60.71
				Clays [%]:	33.00

Hydrometer Done By:	Caitlin Jacobson
Wash Done By:	Caitlin Jacobson

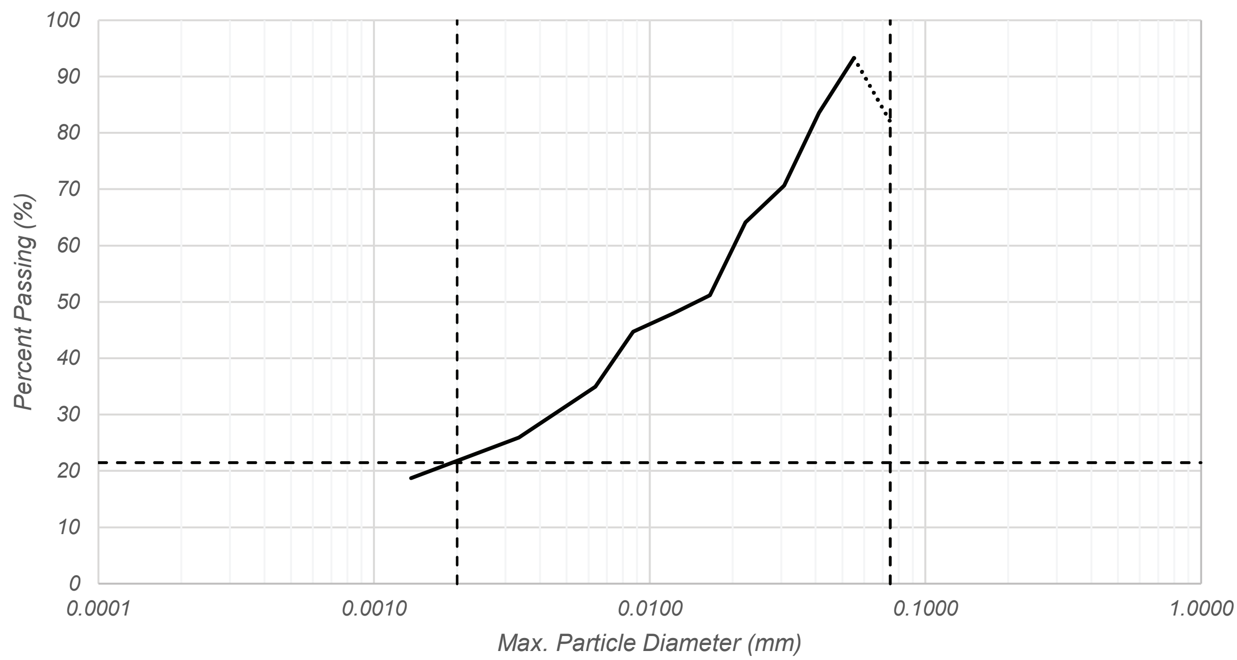
Portland State University

Hydrometer Test

Date Tested: March 14, 2024

Project:	Minto-Brown	**Assumed Gs:**	2.7	**Beg. Depth (ft):**	3.5
Boring:	HA-02	**Dry Mass (g):**	49.0	**End Depth (ft):**	4
Sample:	2	**Hydrometer:**	151H	**Ave. Depth (ft):**	3.75

Time (min)	**Temp (°C)**	**Hydrometer Readings**		**Corrections**			**Max. Particle Diameter (mm)**	**Percent Passing (%)**
		Control	Slurry	Temperature	Hydrometer	Effective Depth		
0.5	19.9	1.003	1.030	0.01367	1.027	8.4	0.055088	93.31
1	19.9	1.002	1.026	0.01367	1.024	9.4	0.041206	83.59
2	19.9	1.002	1.022	0.01367	1.020	10.5	0.030795	70.62
4	19.9	1.002	1.020	0.01367	1.018	11.0	0.022288	64.14
8	19.9	1.002	1.016	0.01367	1.014	12.1	0.016529	51.18
15	19.9	1.002	1.015	0.01367	1.013	12.3	0.012170	47.93
30	20	1.002	1.014	0.01365	1.012	12.6	0.008710	44.69
60	20.1	1.002	1.011	0.01363	1.009	13.4	0.006351	34.97
223	20.5	1.002	1.008	0.01357	1.006	14.2	0.003351	25.96
1432	20.4	1.002	1.006	0.01358	1.004	14.7	0.001362	18.77



P200 Wash

Date Tested:	March 14, 2024		
Container ID:	B-C		
Container Tare (g):	170.3		
Dry Mass Before + Tare (g)	N/A	Dry Mass Before (g):	49.0
Dry Mass After + Tare (g)	179.1	Dry Mass After (g):	8.8

Soil Breakdown

Coarse [%]:	17.98
Fines Fraction [%]:	82.02
Silts [%]:	60.52
Clays [%]:	21.50

Hydrometer Done By:	Caitlin Jacobson
Wash Done By:	Caitlin Jacobson

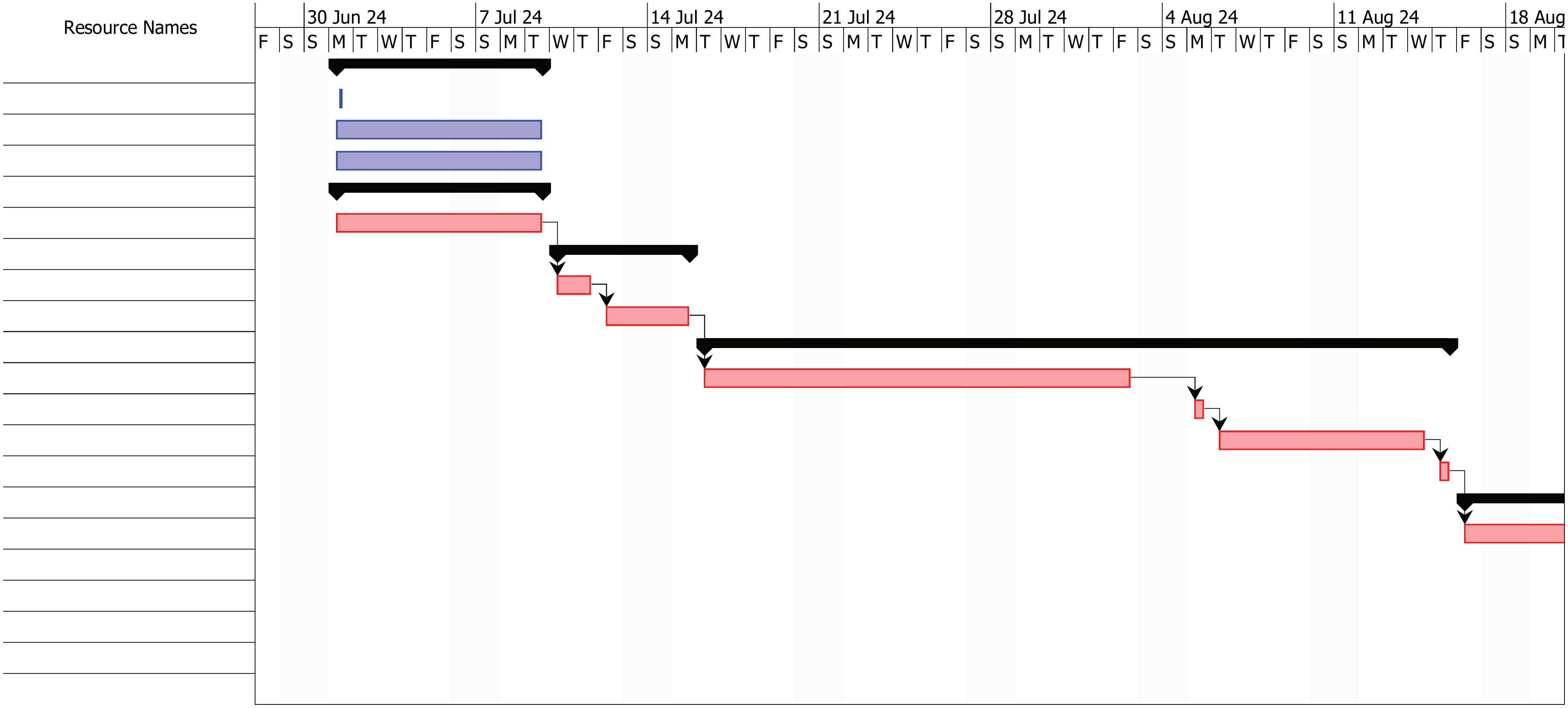
Appendix D
Construction Cost Estimate

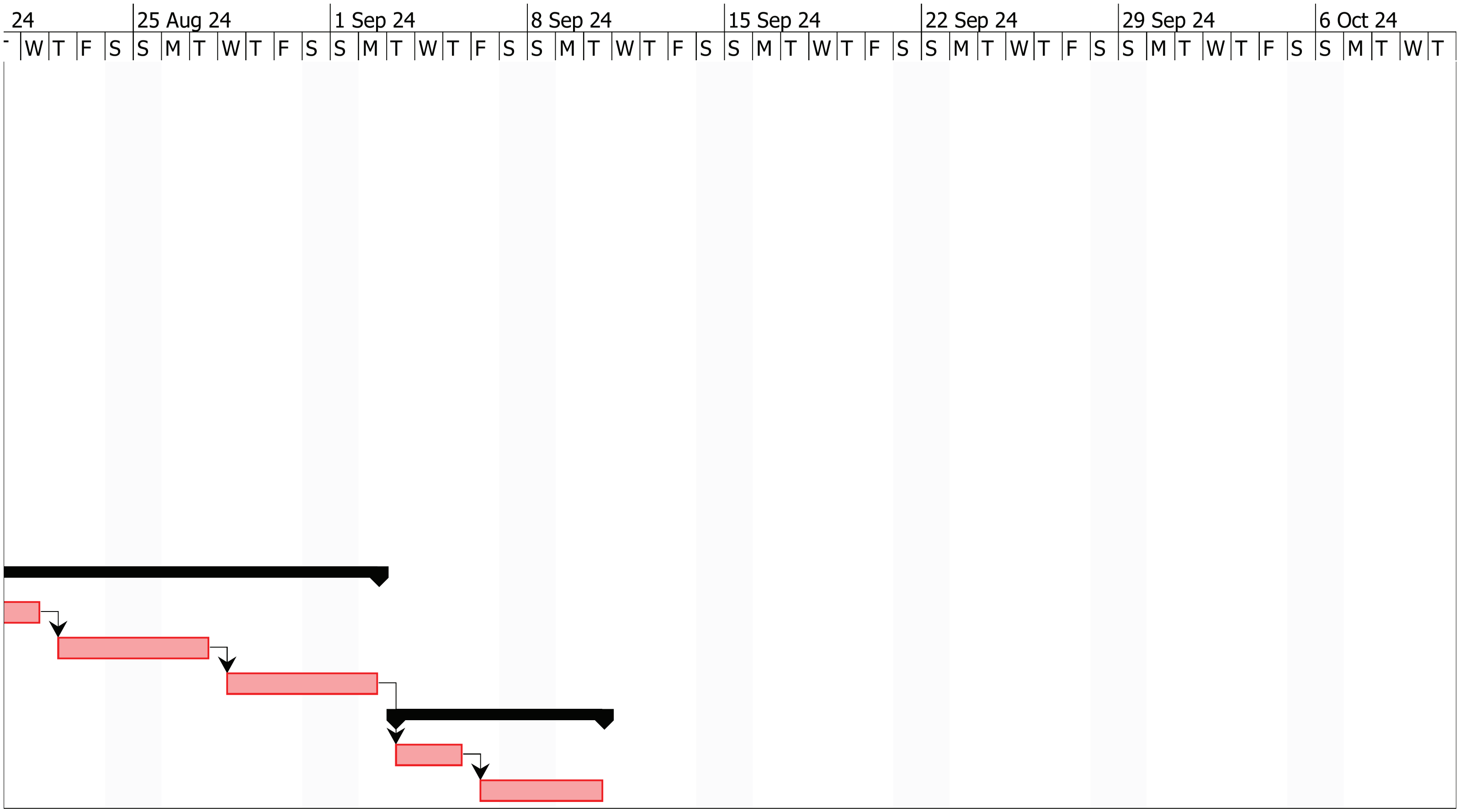
CONSTRUCTION COST ESTIMATE:

	Bid Item	Unit	Unit Cost	Estimated Qty	Labor Cost	Equipment Cost	Material Cost	Direct Cost
	Foundation							
1	Mobilization	ea	$120,000	1				$120,000
2	Clearing	acre		0.6	$1,440.00	$1,750.00	-	
3	Excavation	cubic yd	$50	232	$11,600.00			
	Totals:				$13,040.00	$1,750.00		
	Section Total:							$14,790.00
	Substructure							
1	Precast Reinf. Concrete Column 20.5' high, 12" x 12"	ea	$4,200	128	$16,600.00	$9,000.00	$537,600.00	
	Totals:				$16,600.00	$9,000.00	$537,600.00	
	Section Total:							$563,200.00
	Superstructure							
1	Concrete Ramp	ea	$16,000	2	$1,000.00	$2,000.00	$32,000	
2	Precast Reinf. Concrete Planks, 6" thick	sq ft	$8	15120	$1,300.00	$2,400.00	$120,960	
3	Concrete Curbs, 20' x 6"	cy	$200	325	$3,500.00	$12,000.00	$65,000	
4	Precast Reinf. Concrete Beam, 20' span, 12" x 20"	ea	$3,200	128	$29,700.00	$7,150.00	$409,600	
	Totals:				$35,500.00	$23,550.00	$627,560	
	Section Total:							$686,610.00
							TOTAL:	$1,384,600.00

APPENDIX E
CONSTRUCTION SCHEDULE

		Name	Duration	Start	Finish	Predecessors
1		**Preconstruction**	**7 days**	**7/1/24 8:00 AM**	**7/9/24 5:00 PM**	
2		Preconstruction Meeting	0.25 days	7/1/24 11:00 AM	7/1/24 2:00 PM	
3		Submittals	7 days	7/1/24 8:00 AM	7/9/24 5:00 PM	
4		Permitting	7 days	7/1/24 8:00 AM	7/9/24 5:00 PM	
5		**Site Investigation**	**7 days**	**7/1/24 8:00 AM**	**7/9/24 5:00 PM**	
6		Survey	7 days	7/1/24 8:00 AM	7/9/24 5:00 PM	
7		**Site Preparation**	**4 days**	**7/10/24 8:00 AM**	**7/15/24 5:00 PM**	
8		Foot Traffic Control Plan Setup	2 days	7/10/24 8:00 AM	7/11/24 5:00 PM	6
9		Equipment Mobilization into Park	2 days	7/12/24 8:00 AM	7/15/24 5:00 PM	8
10		**Foundation**	**23 days?**	**7/16/24 8:00 AM**	**8/15/24 5:00 PM**	
11		Excavation	14 days	7/16/24 8:00 AM	8/2/24 5:00 PM	9
12		Proof Roll and Elevation Check	1 day	8/5/24 8:00 AM	8/5/24 5:00 PM	11
13		Footings Install	7 days	8/6/24 8:00 AM	8/14/24 5:00 PM	12
14		Compaction and Grade Checks	1 day?	8/15/24 8:00 AM	8/15/24 5:00 PM	13
15		**Boardwalk**	**12 days**	**8/16/24 8:00 AM**	**9/2/24 5:00 PM**	
16		Beams Intall	4 days	8/16/24 8:00 AM	8/21/24 5:00 PM	14
17		Columns Install	4 days	8/22/24 8:00 AM	8/27/24 5:00 PM	16
18		Slab Install	4 days	8/28/24 8:00 AM	9/2/24 5:00 PM	17
19		**End of Project**	**6 days**	**9/3/24 8:00 AM**	**9/10/24 5:00 PM**	
20		Construction Site Cleanup	3 days	9/3/24 8:00 AM	9/5/24 5:00 PM	18
21		Landscaping Finish	3 days	9/6/24 8:00 AM	9/10/24 5:00 PM	20


Resource Names
30 Jun 24
7 Jul 24
14 Jul 24
21 Jul 24
28 Jul 24
4 Aug 24
11 Aug 24
18 Aug
F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T


24
25 Aug 24
1 Sep 24
8 Sep 24
15 Sep 24
22 Sep 24
29 Sep 24
6 Oct 24
W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T

Appendix F

Specifications

4.1.1 AASHTO Pedestrian Bridge Requirements:

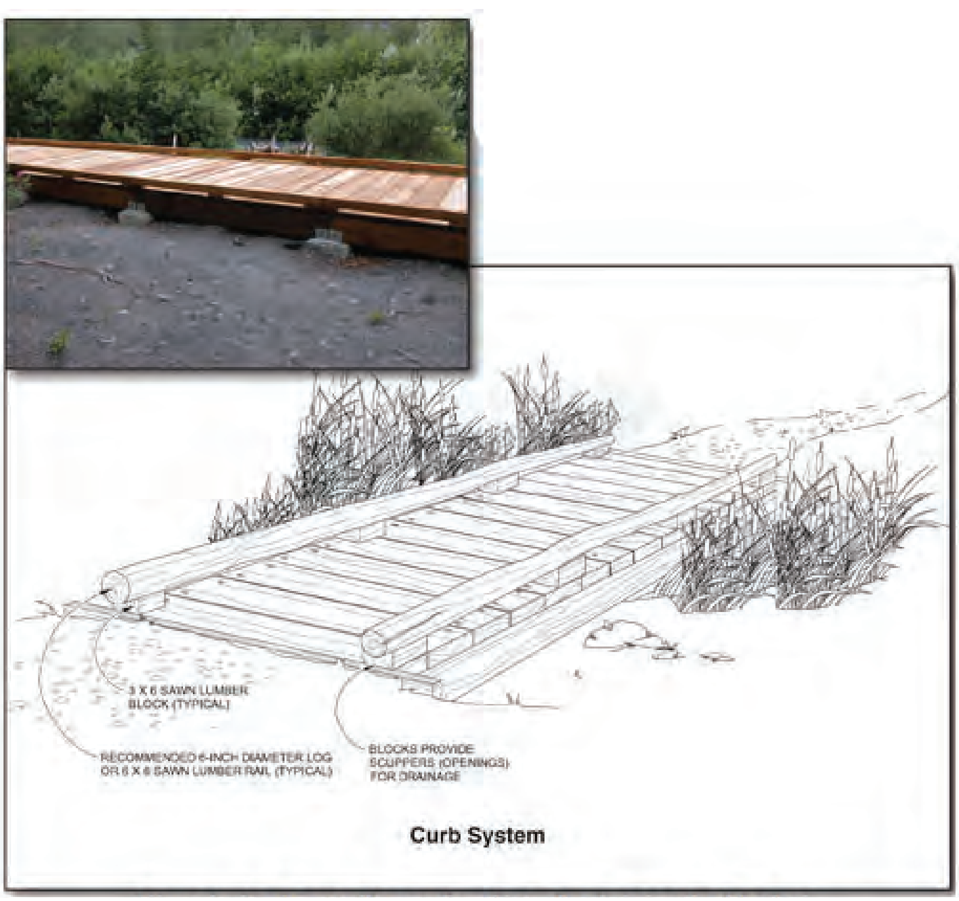
AASHTO's requirements for pedestrian bridges state that this type of structure must be designed for uniform pedestrian loading of 90 psf. Dynamic load allowance is not a required consideration. When determining maximum or minimum live load effect on a member, the least dimension of the loaded area must be greater than or equal to 2.0 ft. Boardwalk spans should have a maximum deflection of 1/360 of the length of the span under unfactored pedestrian live loading.

4.1.2 City of Salem Design Standards:

Pedestrian access routes must be a minimum of four feet in width exclusive of the curb. Pedestrian routes not contained within the right-of-way must have a grade of no more than five percent.

4.1.3 USDA US Forest Service Trail Bridge Rail Systems Report:

Generally, railings are only required on boardwalks in non-remote areas if a boardwalk features a dropoff of four feet or more. All boardwalks that lack a railing system are required to have a curb.



Curb System

Figure 10: Standard timber decking for a boardwalk.
(Source: US Forest Service, 2007.)

ADA Accessibility Standards, from Americans with Disabilities Act via *US Access Board*:

302 Floor or Ground Surfaces

302.1 General. Floor and ground surfaces shall be stable, firm, and slip resistant and shall comply with 302.

2. Areas of sport activity shall not be required to comply with 302.

Advisory 302.1 General. A stable surface is one that remains unchanged by contaminants or applied force, so that when the contaminant or force is removed, the surface returns to its original condition. A firm surface resists deformation by either indentations or particles moving on its surface. A slip-resistant surface provides sufficient frictional counterforce to the forces exerted in walking to permit safe ambulation.

302.3 Openings. Openings in floor or ground surfaces shall not allow passage of a sphere more than ½ inch (13 mm) diameter except as allowed in 407.4.3, 409.4.3, 410.4, 810.5.3 and 810.10. Elongated openings shall be placed so that the long dimension is perpendicular to the dominant direction of travel.

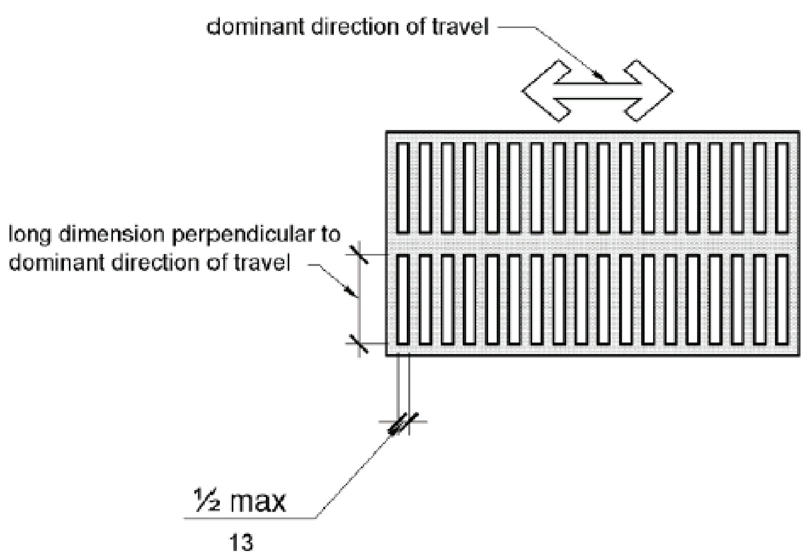


Figure 302.3 Elongated Openings in Floor or Ground Surfaces
303 Changes in Level

303.1 General. Where changes in level are permitted in floor or ground surfaces, they shall comply with 303.

303.2 Vertical. Changes in level of ¼ inch (6.4 mm) high maximum shall be permitted to be vertical.

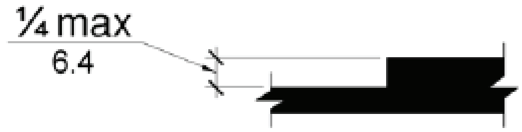


Figure 303.2 Vertical Change in Level

303.3 Beveled. Changes in level between ¼ inch (6.4 mm) high minimum and ½ inch (13 mm) high maximum shall be beveled with a slope not steeper than 1:2.

Advisory 303.3 Beveled. A change in level of ½ inch (13 mm) is permitted to be ¼ inch (6.4 mm) vertical plus ¼ inch (6.4 mm) beveled. However, in no case may the combined change in level exceed ½ inch (13 mm). Changes in level exceeding ½ inch (13 mm) must comply with 405 (Ramps) or 406 (Curb Ramps).

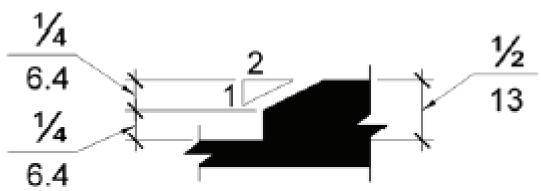


Figure 303.3 Beveled Change in Level

303.4 Ramps. Changes in level greater than ½ inch (13 mm) high shall be ramped, and shall comply with 405 or 406.

304 Turning Space

304.1 General. Turning space shall comply with 304.

304.2 Floor or Ground Surfaces. Floor or ground surfaces of a turning space shall comply with 302. Changes in level are not permitted.

EXCEPTION: Slopes not steeper than 1:48 shall be permitted.

Advisory 304.2 Floor or Ground Surface Exception. As used in this section, the phrase "changes in level" refers to surfaces with slopes and to surfaces with abrupt rise exceeding that permitted in Section 303.3. Such changes in level are prohibited in required clear floor and ground spaces, turning spaces, and in similar spaces where people using wheelchairs and other mobility devices must park their mobility aids such as in wheelchair spaces, or maneuver to use elements such as at doors, fixtures, and telephones. The exception permits slopes not steeper than 1:48.

304.3 Size. Turning space shall comply with 304.3.1 or 304.3.2.

304.3.1 Circular Space. The turning space shall be a space of 60 inches (1525 mm) diameter minimum. The space shall be permitted to include knee and toe clearance complying with 306.

304.3.2 T-Shaped Space. The turning space shall be a T-shaped space within a 60 inch (1525 mm) square minimum with arms and base 36 inches (915 mm) wide minimum. Each arm of the T shall be clear of obstructions 12 inches (305 mm) minimum in each direction and the base shall be clear of obstructions 24 inches (610 mm) minimum. The space shall be permitted to include knee and toe clearance complying with 306 only at the end of either the base or one arm.

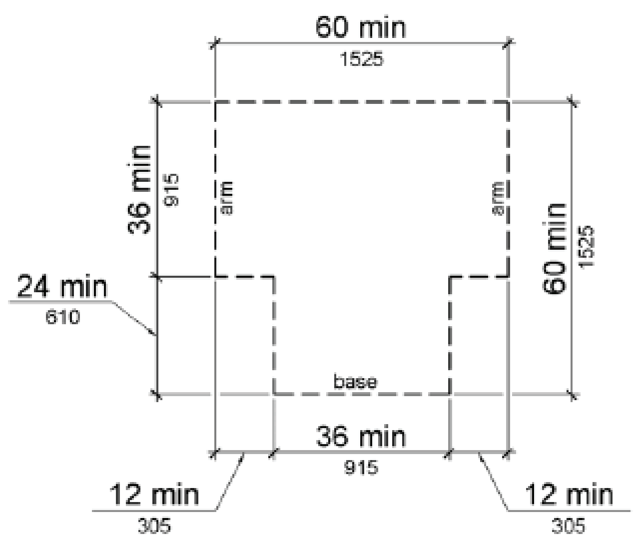


Figure 304.3.2 T-Shaped Turning Space

304.4 Door Swing. Doors shall be permitted to swing into turning spaces.

403 Walking Surfaces

403.1 General. Walking surfaces that are a part of an accessible route shall comply with 403.

403.2 Floor or Ground Surface. Floor or ground surfaces shall comply with 302.

403.3 Slope. The running slope of walking surfaces shall not be steeper than 1:20. The cross slope of walking surfaces shall not be steeper than 1:48.

403.4 Changes in Level. Changes in level shall comply with 303.

403.5 Clearances. Walking surfaces shall provide clearances complying with 403.5.

EXCEPTION: Within employee work areas, clearances on common use circulation paths shall be permitted to be decreased by work area equipment provided that the decrease is essential to the function of the work being performed.

403.5.1 Clear Width. Except as provided in 403.5.2 and 403.5.3, the clear width of walking surfaces shall be 36 inches (915 mm) minimum.

EXCEPTION: The clear width shall be permitted to be reduced to 32 inches (815 mm) minimum for a length of 24 inches (610 mm) maximum provided that reduced width segments are separated by segments that are 48 inches (1220 mm) long minimum and 36 inches (915 mm) wide minimum.

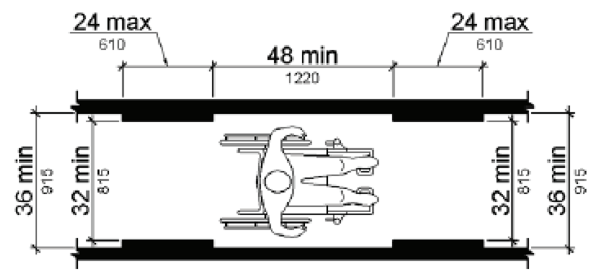


Figure 403.5.1 Clear Width of an Accessible Route

403.5.2 Clear Width at Turn. Where the accessible route makes a 180 degree turn around an element which is less than 48 inches (1220 mm) wide, clear width shall be 42 inches (1065 mm) minimum approaching the turn, 48 inches (1220 mm) minimum at the turn and 42 inches (1065 mm) minimum leaving the turn.

EXCEPTION: Where the clear width at the turn is 60 inches (1525 mm) minimum compliance with 403.5.2 shall not be required.

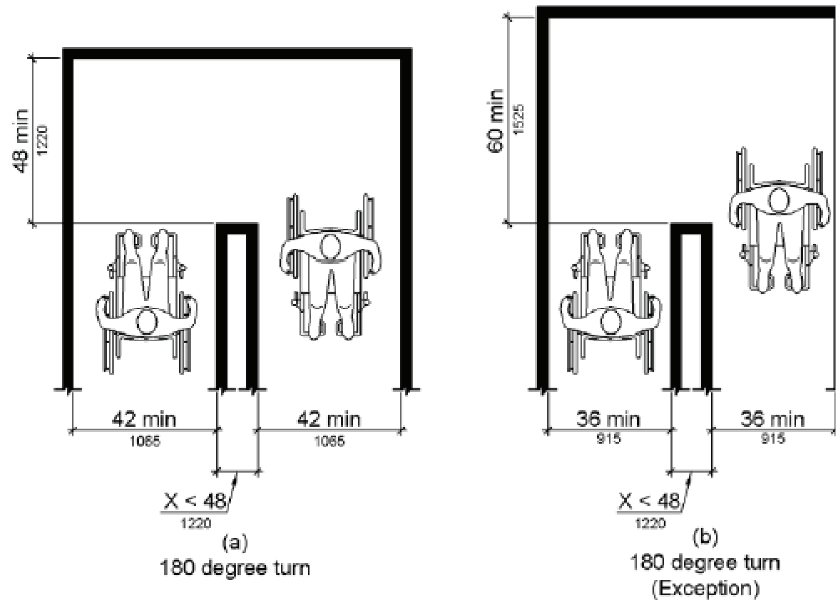


Figure 403.5.2 Clear Width at Turn

403.5.3 Passing Spaces. An accessible route with a clear width less than 60 inches (1525 mm) shall provide passing spaces at intervals of 200 feet (61 m) maximum. Passing spaces shall be either: a space 60 inches (1525 mm) minimum by 60 inches (1525 mm) minimum; or, an intersection of two walking surfaces providing a T-shaped space complying with 304.3.2 where the base and arms of the T-shaped space extend 48 inches (1220 mm) minimum beyond the intersection.

403.6 Handrails. Where handrails are provided along walking surfaces with running slopes not steeper than 1:20 they shall comply with 505.

4.2 Regulatory Compliance

From City of Salem Department of Public Works Administrative Rules Design Standards:

1.10—Surveying Standards for Plans Submittal
All plans submitted to the City shall be referenced and controlled by the following horizontal and vertical datum:

- Horizontal Datum—North American Datum (NAD) 83, Oregon State Plane Coordinate, North Zone, current EPOCH version
- Vertical Datum—National Geodetic Vertical Datum (NGVD) 1929/47
- Unless otherwise noted or specified, all topographic surveying of existing infrastructure shall be located within the field to ±0.01 feet and illustrated on the

plans with this same level of precision. All improvements shall be designed within an accuracy of ±0.01 feet when compared with the approved plans. Vertical and horizontal control for the project will be described and shown on the cover sheet of the plans.

1.11—Preservation of Trees and Vegetation
Preservation of trees and vegetation is required by SRC. Tree preservation must be addressed during project design. Existing and proposed trees shall be shown on the construction plans as well as any special measures required to construct the project. This information shall include existing and proposed tree locations, varieties, sizes, and protection/removal requirements.

- Special attention shall be given to trees conflicting with such things as pavement, curbs, sidewalks, pipe alignments, etc. Permits are required for all development projects for tree removal and proposed tree planting within the ROW and on City property. All construction projects must meet the requirements of the Administrative Rule for City Trees 109-500-2.

4.3 Permitting

From City of Salem Administrative Rules:

1.16—Permits
All necessary regulatory permits for the project shall be obtained, including those issued by the City and from other agencies, prior to approval of final plans. Permitting issues should be identified during the planning phase of the project to facilitate efficient schedule management.

(a) Erosion Prevention and Sediment Control (EPSC) Permit
EPSC permits are required for all projects beyond certain thresholds established in SRC Chapter 75, where earth disturbing activities will take place. For projects greater than one acre in size, the EPSC permit is obtained from the Oregon DEQ as a 1200-C permit. A copy of the approved 1200-C permit is required before the City will issue a development permit.

For projects less than one acre, the EPSC permit is obtained from the City. Both the 1200-C and the City-issued EPSC permit must be obtained before initiating any earth disturbing activity. Guidance on how to develop an EPSC Plan is provided in Division 007–Erosion Prevention and Sediment Control.

(b) Oregon Department of State Lands & U.S. Army Corps of Engineers Permits
Construction projects that involve a stream crossing, work within the normal high water zone adjacent to a stream, or work within a designated wetland; may require permits from

the Oregon Department of State Lands (DSL), U.S. Army Corps of Engineers (Corps), or both. These permits can take nine months or longer to obtain. The City has mapped most jurisdictional wetlands within its boundaries and Public Works can provide that information upon request. The City requires a copy of all permits required by other agencies before a development permit can be issued for a project. The permit applicant is required to apply, coordinate, and obtain permits mandatory for construction.

(c) Development Permits

Construction plans for private development projects shall be submitted to the Public Works Development Services Section through the Permit Application Center (PAC). Public Works staff is responsible for checking to ensure compliance with these Design Standards and SRC. Submittal requirements for development permits can be obtained from the PAC.

(d) Street Opening Permits

Street Opening permits are required for any excavation in City street pavement. Open cut of streets that have been resurfaced or reconstructed during the past five years are prohibited, unless approved via the Design Exception process. Public Works maintains a current list of these streets. Exception approval will require more rigorous street and trench repair measures to ensure integrity of newly paved streets.

(e) Excavation and Fill Permit

If the proposed project is within a landslide hazard area, an Excavation and Fill permit will be required. These permits are also required if fill is being placed in a City easement. These conditions may also trigger the need for a geotechnical investigation (see Section 1.12–Geotechnical Evaluations).

(f) Tree Permits

Permits are required to prune, remove, install lights or other attachments, collect biological materials, or engage in ground disturbing activities within the Critical Tree Zone of City trees pursuant to SRC Chapter 86 and Administrative Rule 109-500-2.

APPENDIX G

QC CHECKLIST

Checker 1	Checker 2	Checklist Item
..	..	**General**
CJS	JAZ	*Proper grammar, spelling, punctuation, etc.*
CJS	JAZ	*Template followed*
CJS	JAZ	*Consistent formatting*
CJS	JAZ	*CEE Writing Style Guide followed*
CJS	JAZ	*Technical writing style used (clear, concise, and easy to understand)*
CJS	JAZ	*Work submitted in proper format*
CJS	JAZ	*Descriptive file name*
		Cover Page
CJS	JAZ	*Project Title*
CJS	JAZ	*Team # and Name*
CJS	JAZ	*Team Member Names*
CJS	JAZ	*Client Name*
CJS	JAZ	*Relevant figure*
CJS	JAZ	*PSU logo & Capstone Caption/Disclaimer*
		Table of Contents
CJS	JAZ	*All sections, subsections listed, with page numbers*
CJS	JAZ	*Appendices listed in order (no page numbers)*
		1.0 Project Background
CJS	JAZ	*Provide an introductory sentence to describe the sections and subsections.*
		1.1 Project Overview
CJS	JAZ	- *Project location w/ figure*
CJS	JAZ	- *Need/purpose of project*
CJS	JAZ	- *Work completed to date*
		1.2 **Existing Conditions**
CJS	JAZ	*Describe the project site in detail. Relevant information may include:*
CJS	JAZ	- *Vegetation*
CJS	JAZ	- *Soil*
Checker 1	**Checker 2**	**Checklist Item**

		1.3 Stakeholders
CJS	JAZ	- *Identify other interested parties*
CJS	JAZ	- *Explain each party's stake/interest*
		2.0 Alternatives Analysis
CJS	JAZ	*Provide a list detailing alternatives under consideration*
CJS	JAZ	*Provide criteria and an appropriate numerical scale*
CJS	JAZ	*Provide a table clearly showing the total values for each alternative*
		3.0 Design Development
CJS	JAZ	*Provide a detailed summary and discussion of design*
CJS	JAZ	*Discussion of calculations*
CJS	JAZ	*Discussion of soil testing*
CJS	JAZ	*Discussion of construction schedule*
CJS	JAZ	*Discussion of construction cost estimate*
		4.0 Design Requirements, Regulatory Compliance, and Permitting
CJS	JAZ	*Provides references to City, State, and Federal guidelines that will be followed within the design*
		References
CJS	JAZ	*References are properly formatted*
		Appendices
CJS	JAZ	*Drawings*
CJS	JAZ	*Calculations*
CJS	JAZ	*Soil testing*
CJS	JAZ	*Construction Cost Estimate*
CJS	JAZ	*Construction Schedule*
CJS	JAZ	*Specifications*
		QA/QC Checklist
CJS	JAZ	*Fill out the provided QA/QC checklist*
6/9/2024	6/9//2024	*Date QC Checklist completed*

Portland State University

Minto-Brown Island Park Boardwalk

Prepared by:
Scott Allan, Caitlin Jacobson,
Colby Seifert, Julia Skillin,
Anna Sosa, John Zaikoski

Team Organization:

Outline

- ➔ Background
- ➔ Design Alternatives
- ➔ Material Alternatives
- ➔ Design Process
- ➔ Cost & Construction Estimate
- ➔ Next Steps

Background

The Park

- 1200 acres & 29 miles of trails
  - Hiking, biking, fishing
- Diverse wildlife
  - Beavers

The Problem:

- Flooding & pooling
- Design assumption: 1 ft of standing water

The Goal:

- Maximize year-round usage
- Minimize environmental disturbance

Design Alternatives Analysis

Alternative Analysis Criteria

- Three alternatives
- Five Criteria
- Weighted scoring based on priorities

Criteria	Possible Scores	Conditions
Feasibility	1	City of Salem will not approve
	10	City of Salem will approve
Maintenance	1	Extensive setup and maintenance
	3	Moderate setup and maintenance
	10	Low setup and maintenance
Construction Cost	1	High Cost
	5	Moderate Cost
	10	Low Cost
Environmental Impact	1	High environmental impact and/or change
	5	Moderate environmental impact and/or change
	10	Low environmental impact and/or change
Bicyclist & Pedestrian Safety/Impact	1	No improvement in cyclist or pedestrian safety
	3	Improvement in cyclist or pedestrian safety
	5	High Improvement in cyclist or pedestrian safety

Embankment

Pros:
- Elevated vantage point

Cons:
- Highly disruptive
- Ongoing maintenance
  - Erosion control
- Expensive

Floating Boardwalk

Pros:

- Usable year round
- Recycled materials for buoys

Cons:

- Bulky design
- High cost
- More suitable as a dock

Fixed Boardwalk

Pros:

- Simple construction
- Several material options & suppliers

Cons:

- Variable maintenance depending on the material


Chosen Design:
Fixed Boardwalk

Materials Analysis

Material Analysis Criteria

- Three alternatives
- Five Criteria
- Weighted scoring based on priorities

Criteria	Description	Weight
Lifespan	Material longevity (years)	High (Max score: 10)
Maintenance	Required frequency of upkeep	High (Max score: 10)
Unit weight	Material weight	Medium (Max score: 5)
Cost	Upfront construction cost	Medium (Max score: 5)
Construction duration	Expected time to completion	Low (Max score: 3)

Timber

Pros:

- Readily available
  - Easy to use
- Aesthetics
- Low cost

Cons:

- Ongoing maintenance
  - Rot, decay, infestation, etc.
- Slip hazard

Composite Decking

Pros:
- Minimal maintenance
  - Not prone to decay
- Aesthetics

Cons:
- Potential slip hazard
- Higher cost

Precast Concrete

Pros:

- High durability
- Low maintenance
- Minimal slip hazard

Cons:

- Heavy machinery required for installation
- Heavy
    - Site is wetland

Chosen Material: Precast Concrete

Design Development

- ~~Design Alternative~~
  - Standard Boardwalk
- ~~Material Analysis~~
  - Precast Concrete
- Constraints
  - Dimensions
  - Code & regulation
  - ADA
  - Shared Path
- Research
  - Existing structures
- Designing
  - Loading requirements
  - Top-down

Constraints and Considerations

Location

- Two primary options

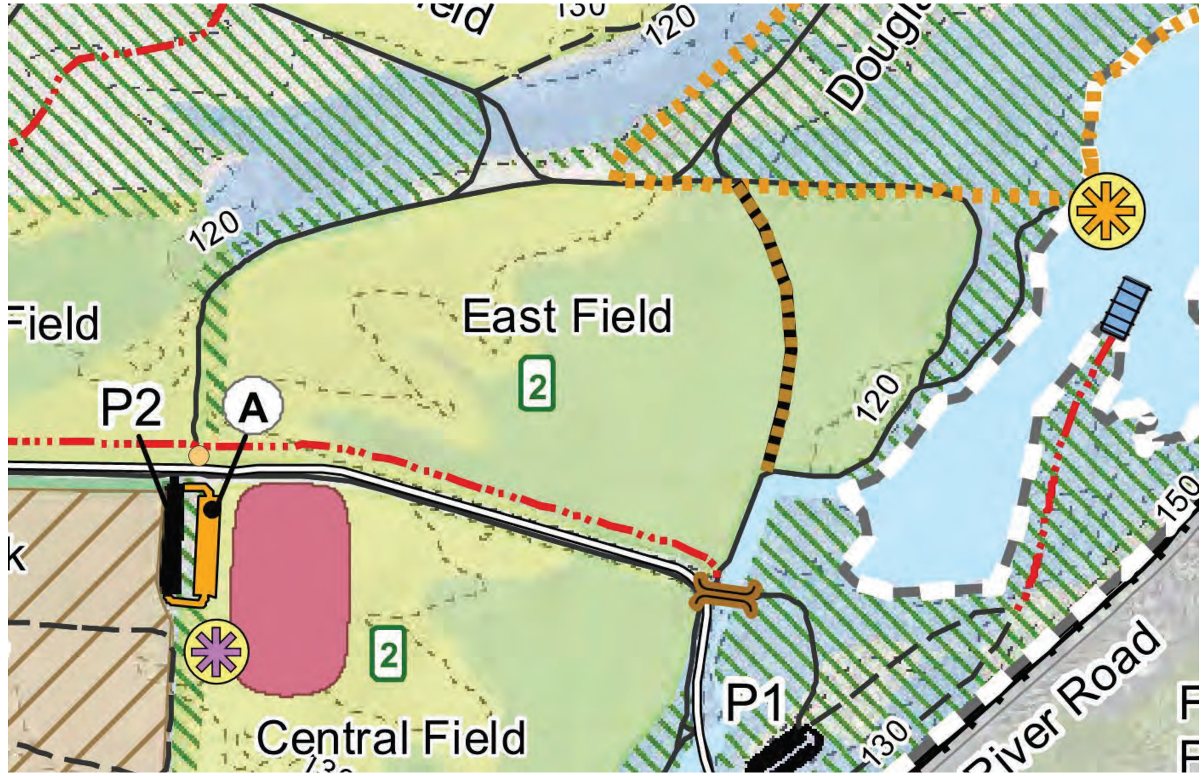
Height

- Flooding: ~1 ft
- Elevation: 3 ft max

Width

- ADA Considerations
- Shared Path

Budget Constraints



Finalized Path

Length and location

- bypasses flooding
- budget-minded design

Height

- Approximately 2 ft

Width

- 12 ft

Research

- Existing structures
  - Is this possible? Realistic? Pretty?
- Plan sets
- PermaTrak
  - Focuses on designs for boardwalk/decking projects

Wolf River Greenway, Tennessee: 2,681 ft long, 15.33 ft wide (PermaTrak)

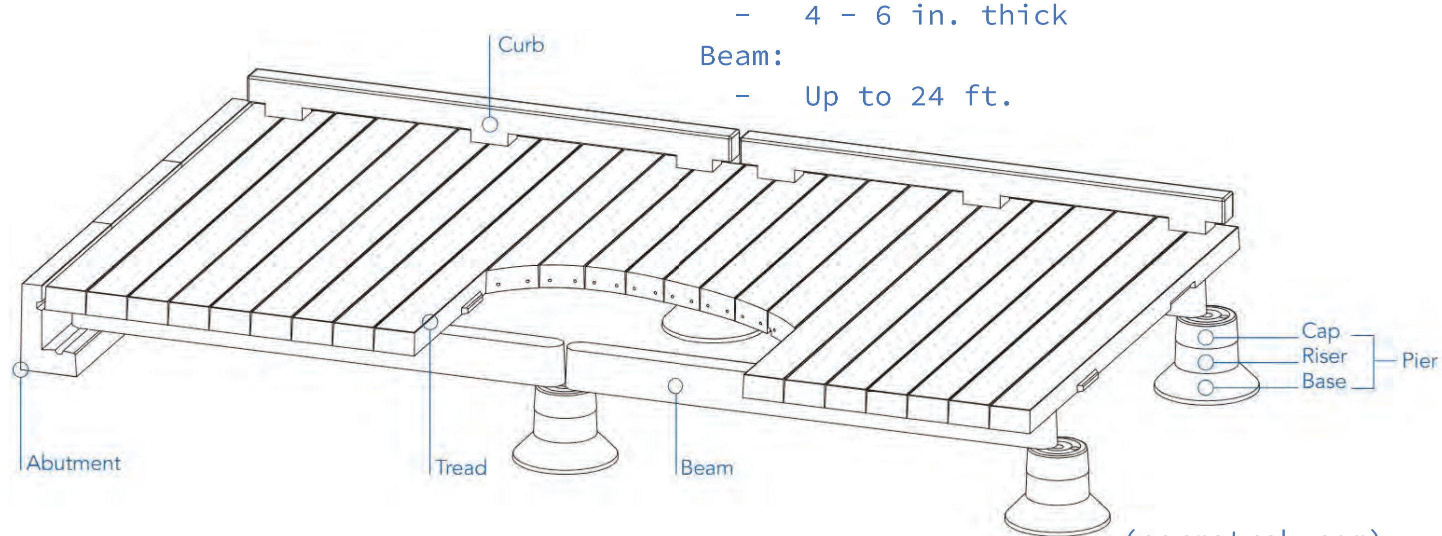
Design: Assumptions

- Grade 60 Steel
- Concrete:
  - f’c = 4000 psi
  - 150 pcf

Reinforced, precast concrete components

Tread:
- 4 - 15 ft. long
- 2 - 4 ft. wide
- 4 - 6 in. thick

Beam:
- Up to 24 ft.



(permatrak.com)

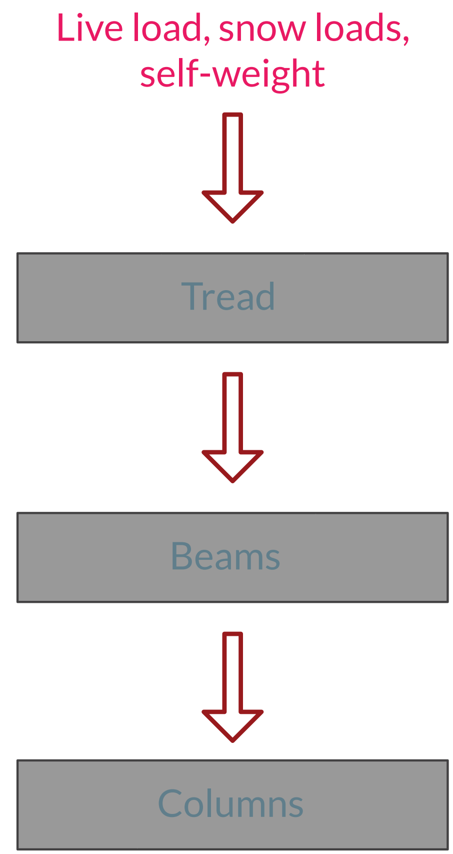
Design: Loading

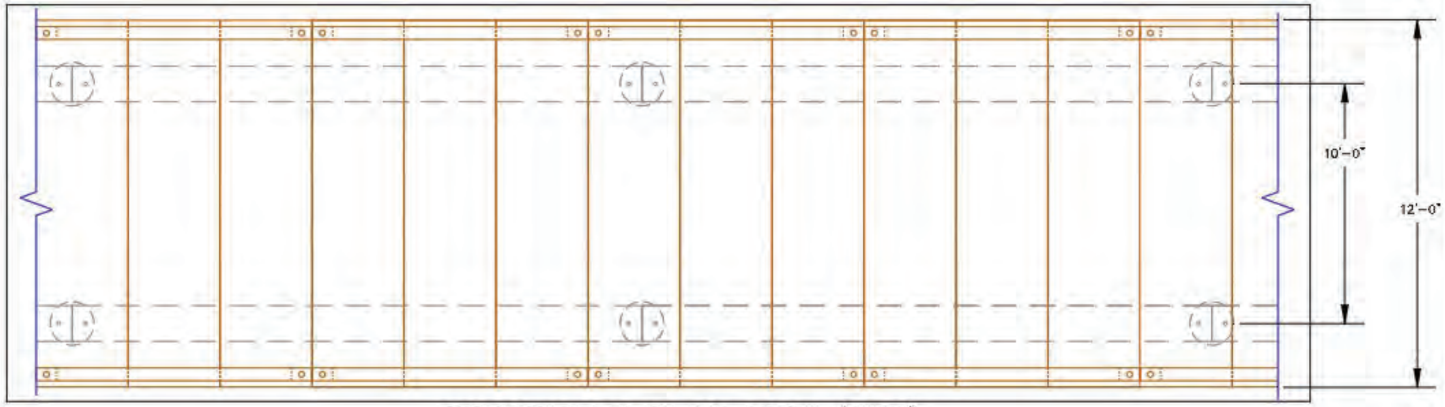
- Dead, live, and snow loads
- Top-down design:
  - Ensure every “layer” can resist the load above

→ Slab/deck

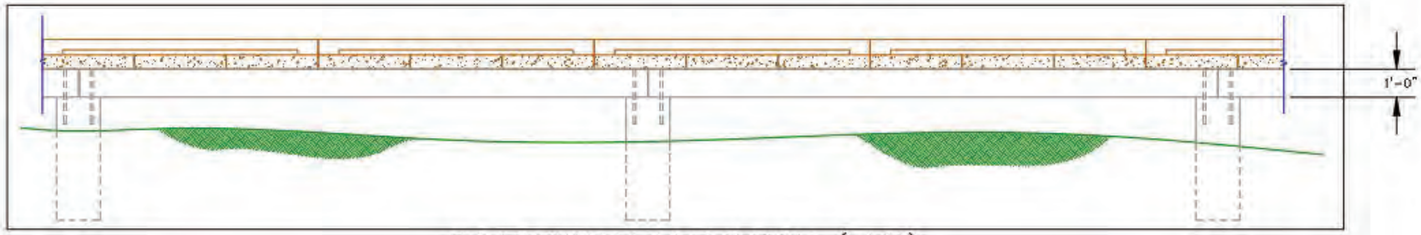
→ Beam

→ Columns/footings

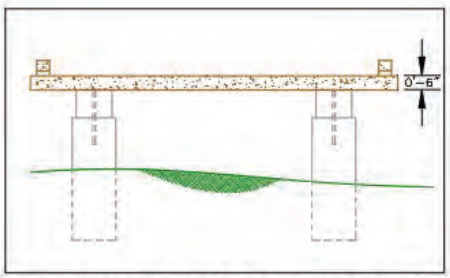




BOARDWALK PLAN VIEW (TYP)



BOARDWALK ELEVATION (TYP)



SECTION OF BOARDWALK (TYP)

DATE:	6/5/24
DRAWN BY:	JULIA SKILLIN
CHECKED BY:	
APPROVED BY:	

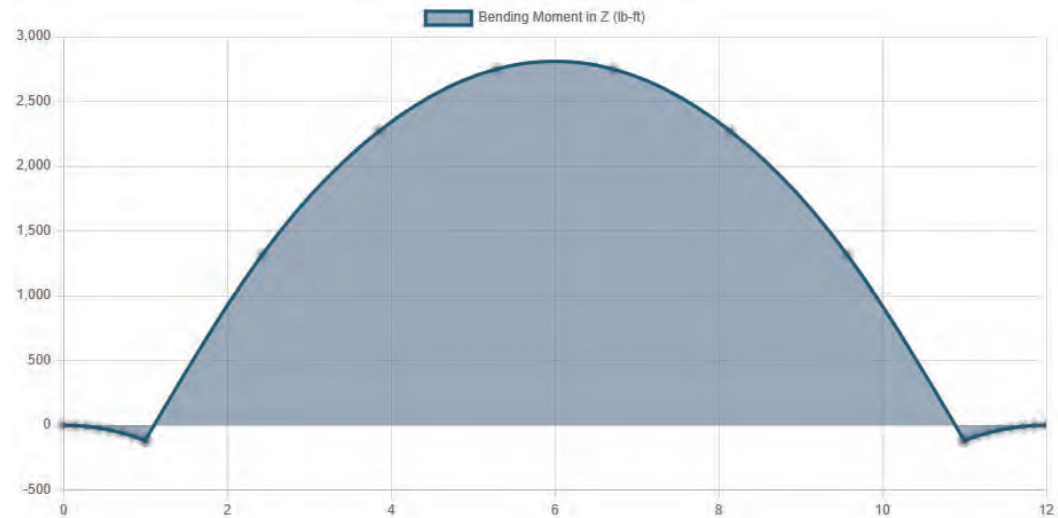
Maseeh College of Engineering and Computer Science
PORTLAND STATE UNIVERSITY

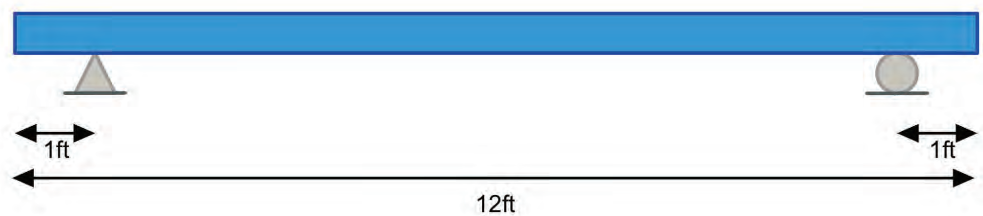
CITY OF SALEM
MINTO-BROWN PARK BOARDWALK

CE 484 GROUP 8	SECTIONS	REV A
SCALE: AS SHOWN	SHEET 3 OF 5	

Design: Tread

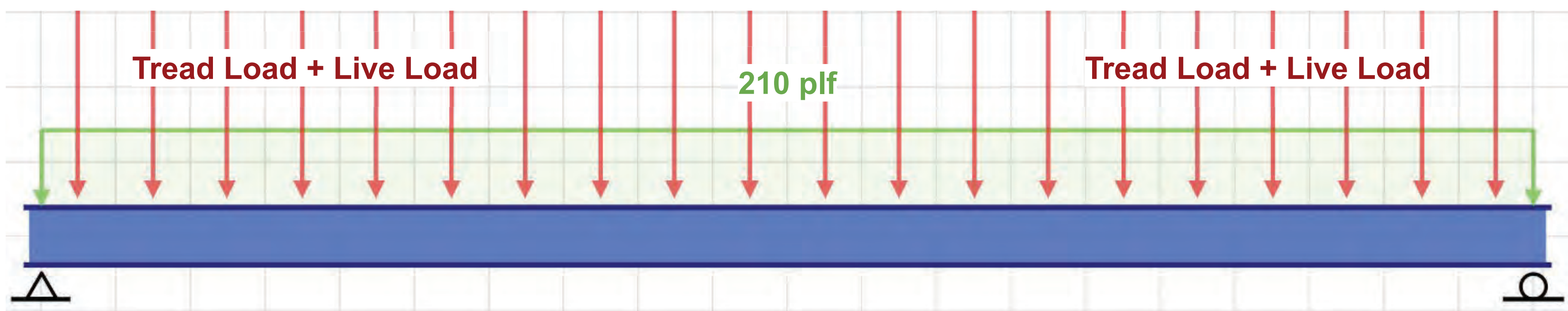
- 12 ft wide, 10 ft span between supports (1’ OC from edge)
- Reinforced, 2#3 bars
- Mu = 2.75 kip-ft
- Mcr = 2.85 kip-ft
- **ΦMn = 4.25 kip-ft**
- Vu = 1.17 kip
- Vu (@ d=4.5) = 88 lbs
- **ΦVn = 12.5 kip**
- No stirrups required





Design: Final in Progress

- Beams
  - 20 ft long
  - Supporting 20 tread sections
  - M_u = 80.7 kip-ft
  - **ΦM_n = 98.7 kip-ft**
- Columns/footings
  - In the works



Construction Cost & Timeline

Costs & Construction Timeline

Cost:

Foundation: $12,950.00

Substructure: $484,00.00

Superstructure: $508,579.60

Grand Total: $1,006,000.00

Construction:

Site Investigation & Preparation: 18 days

Foundation: 23 days

Decking Install: 12 days

Project Closeout: 6 days

Grand Total: 59 days

Recommendations & Next Steps

Recommendations

- Construct a precast concrete boardwalk to provide an elevated pathway safe from typical flood depths
- Reroute path to maintain trail continuity over a shorter distance, further from the slough

Next Steps

- Archaeological evaluation of the site
- Geotechnical investigation to verify that foundation design is adequate for site soil
- Account for deflection
- Account for moving load (ATV)

Thank you.

References

Slide 4: Google Earth

Slide 5: Jacobson, Caitlin

Slide 7:
https://www.cityofsalem.net/community/things-to-do/volunteer-get-involved/volunteer-to-join-the-park-patrol-in-minto-brown-island-park

Slide 9: https://www.pca.state.mn.us/news-and-stories/how-climate-resilience-grants-prevent-flooding

Slide 10:
https://www.tripadvisor.com/LocationPhotoDirectLink-g4876912-d8557248-i333018815-Prince_Edward_Island_National_Park-Saint_Peters_Bay_Prince_Edward_Islan.html

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Slide 12:https://fredsmithcompany.net/white-oak-greenway/

References continued

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Slide 15: https://www.bendparksandrec.org/park/drake-park-and-mirror-pond/

Slide 16: https://lockesolutions.com/concrete-boardwalk/

Slide 17: https://www.permatrak.com/news-events/permatrak-offers-new-expanded-precast-concrete-tread-length

Slide 19: Google Earth

Slide 25: Moment Diagram- skyciv.com

Slide 26: skyciv.com

Slide 30: https://www.reddit.com/r/SALEM/comments/lhdb2r/minto_brown_park/

Slide 32: https://www.cnbc.com/2020/12/15/construction-sites-look-to-automated-tech-other-innovations-.html

SCI Directors and Staff

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