City of West Linn

Memorandum

Date: **September 26, 2014**

To: **John Kovash, Mayor**
Members, West Linn City Council

From: **Chris Jordan, City Manager** *CJ*

Subject: **Bolton Reservoir Site Analysis**

The City's engineering consultant for the Bolton Reservoir, Murray Smith and Associates (MSA), has completed its analysis of possible locations for the new Bolton Reservoir. That analysis is attached.

MSA reviewed dozens of possible locations in West Linn for the new reservoir and reduced the list to 16 viable sites. All of those are included in the chart marked Table A-1. However, only 4 sites rise to the level of any further consideration and are listed in Table 1 on Page 8. The top location is the current site and a new reservoir there is estimated to cost $9 million. Sites 2 and 3 are both more expensive and are located in Wilderness Park which is protected as a park by the City Charter; therefore, requiring a community vote to be used as a reservoir site. Alternative site 4 is more than twice as expensive ($22 million) and is located on property owned by the West Linn/Wilsonville School District.

Based on the analysis, staff and MSA will be recommending that the current location of the Bolton Reservoir be used to site the new reservoir.

We have scheduled a Council review of this document for your October 20 work session. Please let us know if you have any questions.

Attachment

Murray, Smith & Associates, Inc.
Engineers/Planners

121 S.W. Salmon, Suite 900 ■ Portland, Oregon 97204-2919 ■ PHONE 503.225.9010 ■ FAX 503.225.9022

TECHNICAL MEMORANDUM

DATE: September 24, 2014

PROJECT: 14-1586.301

TO: Mr. Lance Calvert, Public Works Director/City Engineer
Mr. Jim Whynot, Operations Supervisor
City of West Linn, OR

FROM: Thomas P. Boland, P.E.
Murray, Smith & Associates, Inc.

RE: City of West Linn Bolton Reservoir Replacement
Reservoir Siting Alternatives Analysis

REGISTERED PROFESSIONAL ENGINEER 59976 OREGON JULY 13, 1999 THOMAS P. BOLAND
EXPIRES 12-31-15

Introduction

The City of West Linn (City) is proposing to replace the existing 2.5 Million Gallon (MG) Bolton Reservoir with a new 4.0 MG reservoir. In accordance with the City's authorization, Murray, Smith & Associates, Inc. (MSA) has completed a reservoir siting alternatives analysis for the City's proposed Bolton Reservoir replacement. This memorandum presents findings and recommendations resulting from this reservoir siting study work.

Background

The existing Bolton Reservoir site is located northerly of Skyline Drive on City owned property, near the intersection of Skyline Drive and Skyline Circle. The existing reservoir is a concrete slab-on-grade structure with 2:1 (horizontal: vertical) side slopes, constructed in 1913. An interior liner was installed in 1989 and a Hypalon cover was placed over the reservoir in 1995. Previous inspections of the reservoir identified some concrete spalling and some localized cracking. The floating cover for the reservoir appears to be reaching the end of its service life. Based on inspection and recent repairs of holes/tears in the cover in January 2008 and extensive repairs again in 2012, it is beginning to show significant signs of wear, especially at locations where movement occurs, such as around the rain troughs (gutters), and it is likely that the cover will require more frequent repairs in the near term.

Approximately 0.5 MG of the total 2.5 MG volume of the Bolton Reservoir is unusable due to the low elevation of the reservoir floor relative to the higher elevation of the reservoir outlet piping and suction piping of the adjacent Bolton Pump Station, which pumps water from the reservoir into the distribution system's Horton Pressure Zone. Given the reservoir's functional limitations, condition, and age, replacement of the Bolton Reservoir was recommended in the City's previous three Water System Master Plans, including the most recent completed in 2008, in which it was considered a high priority improvement.

In August 2012, MSA completed a conceptual siting analysis for construction of a replacement reservoir at the existing site, which would involve demolition of the existing reservoir and construction of a new 4.0 MG reservoir within the existing site boundaries. The scope of the conceptual siting analysis work included confirming floor and overflow elevations and preliminary tank dimensions, evaluating and recommending reservoir type, completing a preliminary geotechnical evaluation of the site, confirming the orientation of the structure on the site and developing budget level cost estimates to allow the City to proceed with project financing. The evaluation included consideration of the existing physical site constraints, including a localized active landslide within the existing reservoir site; the reservoir site's location within a very large "ancient" landslide, as mapped by DOGAMI; and the potential impacts of subsurface geological conditions on reservoir foundation conditions.

Because of the importance of this large capital investment, the City has decided to investigate other potential site alternatives as part of the initial preliminary engineering phase of the reservoir replacement project.

Purpose and Scope

The purpose of this siting study is to identify and evaluate the adequacy and suitability of potential alternative reservoir sites, and to ultimately assist in identifying a preferred location for the proposed reservoir. The scope of work includes completion of preliminary map studies and field reconnaissance of the project area to identify and evaluate potential alternative reservoir sites. Findings and recommendations resulting from this work are intended to assist the City in selection of a preferred site. Siting study work includes conceptual level analysis to support siting of several configurations of reservoirs with a total volume of 4.0 MG.

Study Area Limits

The primary study area for the reservoir siting work generally includes areas within the City Limits at an elevation range of 430 to 450 feet above mean sea level for a ground level reservoir option, and an elevation range of 370 to 430 feet above mean sea level for an elevated reservoir option with a height of approximately 90 feet. Initial screening of potential sites also included a review of parcels within a lower elevation range of 300 to 370 feet, which would accommodate a taller elevated tank option with a height of up to 150 feet,

which generally represents the upper limit of feasibility for elevated water storage in regions where seismicity is a factor. The study area is shown on the Alternative Site Identification map attached as Figure 1.

Conceptual Level Siting Criteria

Conceptual level siting criteria include site topography, proximity to service area and existing water system infrastructure, dimensioning and layout of the reservoir structure both vertically and horizontally, property size requirements, existing development and land use, geotechnical considerations, and potential relative cost impacts.

Site Topography

The location of a water storage reservoir is governed primarily by the ground elevation of the area the reservoir must serve. The reservoir structure must be placed at an elevation to provide adequate water system pressure to customers and fit the water system hydraulic conditions. For the reservoir siting alternatives, a preliminary reservoir floor elevation of 430 feet and an overflow elevation (high water level) of 450 feet were selected to meet water system hydraulic requirements needed to serve the Bolton Pressure Zones and Horton Pressure Zones, similar to the reservoir elevations proposed for the replacement reservoir at the existing Bolton Site. To meet these hydraulic parameters while providing adequate reservoir foundation conditions on existing ground, potential reservoir sites were primarily investigated with ground topography in the 430 to 450-foot elevation range for a ground level reservoir at-grade or buried, and 370 to 430-foot elevation range for an elevated reservoir with a nominal height of up to 90 feet. These ground elevation bands are illustrated on Figure 1. A screening of lower elevation parcels was also performed for sites that could accommodate an elevated tank up to 150 feet tall, although the cost of constructing such a tall large volume structure in the Pacific Northwest would likely be cost prohibitive due to the seismic requirements.

Proximity to Service Area and Water Transmission Piping

The proximity of potential reservoir site locations relative to the City's existing water system infrastructure has a direct correlation to magnitude of project costs and the feasibility for the site to be integrated into the City's system, depending on the need for additional water transmission piping and pumping facilities. The City's waterline network is illustrated on Figure 1. The existing Bolton Pressure Zone is directly connected to the South Fork Water Board (SFWB) transmission main which delivers water from the City's primary water supply. The Bolton Reservoir is supplied by 18-inch and 24-inch diameter piping from the SFWB transmission main. The Bolton Pump Station is also located at the existing reservoir site, and pumps water from the Bolton Reservoir to the Horton Pressure Zone and Reservoir. Reservoir supply and discharge piping should be constructed at an elevation below the preliminary reservoir floor elevation to accommodate suitable hydraulic operation of the pipelines and reservoir. As part of this study, it was assumed that minimum depth of bury for

reservoir supply and discharge piping would be maintained where possible, while selecting routes along public roadway rights-of-way where feasible.

Reservoir Dimensions

This siting study work includes conceptual level analysis for siting reservoirs at various configurations with a total storage of 4.0 MG and an overflow elevation (high water level) of 450 feet. For the ground level reservoir alternative, constructed at-grade or buried, a single 4.0 MG circular prestressed concrete structure was assumed, with a water depth of 20 feet and diameter of 190 feet. For the elevated reservoir alternative, a single 4.0 MG elevated steel structure was assumed, with a water depth of 45 feet, diameter of 135 feet and nominal height of up to 90 feet tall. It should be noted that a 4.0 MG elevated reservoir is at the upper limits of feasibility for an elevated tank, and that further design level analysis may determine that two 2.0 MG elevated reservoirs are needed. It is anticipated that the elevated reservoir alternative would have a higher construction cost compared to the ground level option, with the typical cost of elevated structures being more than double that of ground level structures. The cost of two 2.0 MG elevated reservoirs would be higher than a single elevated reservoir. In addition, the visual impact of a 90 foot tall 4.0 MG elevated reservoir or two 2.0 MG elevated reservoirs would be significantly greater than a ground level reservoir.

The elevated tank dimensions are based on feasible design standards with water depth and diameter configured for economical construction. Due to this larger standard water depth measured down from the desired 450-foot overflow elevation, the water stored would fall below the optimum elevation range of 430 to 450 feet for the Bolton Pressure zone, resulting in a less desirable option with a large decrease in useable storage. The cost of constructing a single 4.0 MG elevated tank or two 2.0 MG tanks with a depth to diameter ratio similar to the ground level tank to maximize useable storage, would likely be very cost prohibitive and technically challenging with regard to seismic design considerations.

Property Size Requirements

Minimum property size requirements should include a parcel, or parcels, large enough to accommodate the reservoir structure, final grading, site development and access needs, as well as any anticipated operational requirements. Property size would also need to include space for a pump station if the location of the site required a replacement pump station to meet site specific water system hydraulic conditions. Ideally, additional property required for temporary construction staging and operations would be accommodated by the reservoir site, otherwise temporary construction easement acquisition would be necessary. Estimated property size requirements for the various tank configurations range from approximately 2.0 to 3.5 acres, reflecting additional space needed for added site grading on properties with steeper topographic slope conditions. As part of the initial property screening process, all parcels in the City limits larger than 1.5 acres were identified and screened for suitability to identify any potential opportunities.

Maximum 1:1 temporary construction excavation slopes, and proposed 2:1 final grading slopes were assumed for siting both the ground level and elevated reservoir options. Retaining walls, steeper construction slopes or excavation shoring may be used or required during actual construction to minimize land use.

Existing Development and Land Use

The apparent existing use of properties under consideration for the proposed reservoir site were documented as part of this study. Preference was given for vacant properties within the City limits. Very few vacant lots exist within the required elevation range, and many of those are dedicated drainage basins, open spaces or parks, or contain a protected Water Resource Area (WRA) and would conflict with the WRA protection defined in Chapter 32 of the CDC. The current zoning of properties under consideration for use as a proposed reservoir site was also documented.

Siting the proposed reservoir in a City-owned park or open space is currently not an approved use. Chapter XI, Section 46, of the West Linn City Charter requires that nonauthorized uses of a City owned park or open space be approved through a public vote. The Charter states that only facilities directly necessary for the park's use shall be considered authorized, further stating that specific uses considered to be "nonauthorized" include water reservoirs and water tanks, and parking facilities and roads (except as needed for park use and access). The intent of this Charter section is that City-owned parks and open spaces be preserved for recreational use and environmental preservation and enhancement and not used for other purposes or sold or exchanged without the approval of the registered voters of the City of West Linn.

Given the functional limitations, condition, and age of the existing Bolton Reservoir, it is anticipated that demolition of the existing reservoir and old pump station would be completed as part of project construction at any of the alternative reservoir sites. This work would likely include filling and grading the existing Bolton Reservoir.

Geotechnical Considerations

Alternative reservoir site locations were reviewed relative to landslides identified and mapped by DOGAMI (Statewide Landslide Information Database of Oregon, Release 2, 2011). Available DOGAMI landslide mapping information is illustrated on Figure 1. Further geotechnical investigation of alternative sites was not performed as part of this study, therefore the geotechnical suitability of specific alternative sites is unknown.

Preliminary Screening of Potential Reservoir Siting Alternatives

Based on preliminary topographic map studies and field reconnaissance of the project area, an initial broad screening of parcels was performed to identify the potential viable reservoir sites for further analysis. Several sites were found to have stream corridors with associated Metro identified riparian areas which makes the sites unsuitable for development. Some parcels, while of suitable elevation and total acreage, did not accommodate construction of a reservoir due to severe slopes or parcel shape constraints. Further, some potentially suitable properties were already developed with multi-family or condominium units. The economic and social costs of constructing a reservoir at these developed sites make further consideration impractical. Four potential sites were identified and shortlisted for evaluation. A summary of the site screening findings are included in Table A-1, attached in Appendix A.

Potential Reservoir Siting Alternatives

The four potential reservoir site alternatives that were selected through the initial screening process were evaluated and compared based on the following criteria:

- Topography, property size and slope to include consideration of construction cuts and fills, access and staging
- Need for additional permanent utility easements or temporary construction easements.
- Proximity to the City Limits, service area and proposed water transmission piping. It should be noted that a detailed hydraulic evaluation of the system was not performed when evaluating site alternatives. The further the potential reservoir site is located from the existing site, the greater the potential need for significant transmission piping or pumping improvements, and potential complexity and concerns related to water system hydraulics, operations and water quality
- Existing development and land use of the property
- Geotechnical considerations
- Relative conceptual project cost

A summary of key overall findings of the evaluation of siting alternatives is presented below in Table 1, followed by a detailed summary for each site.

Conceptual Level Cost Estimates

In 2012 MSA prepared a detailed preliminary project cost estimate for replacement of the Bolton Reservoir at the existing site. The estimated project cost of $8,835,000 included construction costs plus contingency, and an allowance for engineering, permitting, construction management and City administration. At the concept level, it is assumed that construction of a ground level reservoir at the alternative sites would have a similar construction cost. This estimate was used as a basis for the conceptual cost estimates,

subtracting several site specific cost items and adding costs for piping, pumping, structure reinforcement for rooftop parking, and elevated storage as required.

The conceptual level construction cost estimates were developed for the potential reservoir site alternatives to achieve a feasibility level relative cost comparison. The cost estimates are Class 5 estimates as defined by the American Society of Cost Engineers (AACE). This class is consistent with a 0 to 2 percent complete project definition. Total project cost estimates include an appropriate contingency reflecting the higher level of unknowns at the potential alternative sites, plus an allowance for engineering, permitting, construction management, City administration, and property acquisition as needed. A summary of estimated conceptual level project costs for the proposed reservoir site alternatives is presented in Table 1.

Table 1 | Potential Reservoir Site Alternatives – Information Summary

Reservoir Site Alternative	Notes / Key Issues	Elevation Contours	Lot size (ac) / Dimensions (ft)	Topography (% Slope)	Current Use or Structures/ Zoning	Conceptual Project Cost ($ million)
Site 1 (Existing Site)	Existing Reservoir Site; within mapped ancient landslide; minimal improvements required – close proximity to existing piping and pump station. Site is viable.	430'- 455'	3.23 ac / 340' x 400' (approx.)	Flat to 5%	Reservoir Site/ R-10	$9 M
Site 2 (Wilderness Park, North)	Located in Wilderness Park, a City Charter protected park; within mapped ancient landslide; near existing site; some piping improvements required. Site is viable.	450'- 470'	64.8 ac / 250' x 250' required	Flat to 30%	Parking lot in Wilderness Park / R-10	$11 M*
Site 3 (Wilderness Park, South)	Located in Wilderness Park, a City Charter protected park; outside of mapped ancient landslide; relocate pump station to the site; moderate piping improvements required. Site is viable.	350'- 460'	64.8 ac / 250' x 250' required	20%	Forested area in Wilderness Park / R-10	$13 M
Site 4 (High School)	Located on school property; private property may be required for access from Windsor Terrace; outside of mapped ancient landslide; relocate pump station to the site; moderate piping improvements required; tight site at lower elevation - elevated tanks required with decreased usable storage; near existing stream/riparian area; very high relative cost & visual impact. Site is not viable.	340'- 420'	31 ac / up to 600' x 600' required	20%	Forested area school land / R-10	$22 M

Note: * Add $1.7 M to the Conceptual Project Cost for the option to relocate the existing Bolton Pump Station.

Alternative Site Descriptions

Site 1 (Existing Bolton Reservoir Site)

Site 1, identified on Figure 1, is the location of the existing Bolton Reservoir and Bolton Pump Station. Ground elevations range from 430 to 455 feet. The site slopes northeasterly at approximately 5 percent. Construction of the buried replacement reservoir will require use of the majority of the 3.23 acre site while retaining the existing Bolton Pump Station. Demolition of the existing reservoir and old pump station would be completed as part of the project. New water piping within the reservoir site and along Skyline Circle will be required to connect the replacement reservoir to the distribution system and pump station.

As part of the preliminary geotechnical evaluation of the existing site completed in 2012 by GRI, Inc. (GRI), it was determined that it is within the mapped boundary of the large ancient landslide identified and mapped by DOGAMI (Statewide Landslide Information Database of Oregon, Release 2, 2011). It was GRI's overall opinion that the risk of significant future movement of the large old landslide mass that could impact a reservoir on the site is probably low, but the risk is not totally absent. Due to the large size of the mapped landslide, GRI anticipates that mitigation measures to improve the stability of the ancient landslide are likely not practical or cost effective.

GRI also provided recommendations to address stability related to the small localized landslide at the northeast corner of the site, and the presence of fill along the north side of the existing reservoir. Geotechnical suitability and potential foundation or slope stability improvements will be determined as part of the geotechnical investigation and site specific seismic hazard study to be completed as part of the current preliminary engineering phase.

Site 1 is a preferred viable alternative when considering the close proximity to the existing water system infrastructure, the City's existing use of the site, and that it provides a low cost replacement option relative to other sites.

Site 2 (Wilderness Park Property, North Parking Lot)

Site 2, identified on Figures 1 and 2, is located near the existing Bolton Reservoir site in the vicinity of the paved parking lot in Wilderness Park, southwest of the intersection of Skyline Drive and Clark Street. The parking lot is flat at a ground elevation of approximately 450 feet and surrounded by gentle to steep forested slopes at grades of up to approximately 30 percent. Approximately 2.0 to 2.5 of the park's 64.8 acres would be needed to accommodate construction of a buried reservoir at this site. This would include the area needed for construction cut slopes, construction access to the base of the reservoir, and limited staging area. The Bolton Reservoir site across the street could be an option for additional staging area if needed. The buried reservoir roof structure would need to be more robust to accommodate a permanent rooftop parking lot to replace the existing parking area, increasing

the reservoir construction cost. A conceptual cross-section of the reservoir is illustrated in Figure 3.

It appears that construction and permanent site access could be provided from Clark Street. As shown on Figure 2, approximately 450 linear feet of water supply piping would be required to connect the proposed reservoir to the Bolton Pressure Zone piping in Skyline Drive, and approximately 700 linear feet of piping would be needed to connect the reservoir to the existing Bolton Pump Station at the Bolton Reservoir site.

Similar to Site 1, alternative Site 2 is located within the mapped boundary of the large ancient landslide identified and mapped by DOGAMI. Without additional geotechnical investigation, the geotechnical suitability of Site 2 is unknown.

Siting the proposed reservoir in Wilderness Park is specifically considered to be a "nonauthorized use" of park property in accordance with Chapter XI, Section 46 of the West Linn City Charter, requiring the approval of the registered voters of the City of West Linn.

Based on conceptual budget level costs estimates, it appears that the cost of constructing the replacement reservoir at Site 2 would be more than that of Site 1. Site 2 appears to be a technically and financially feasible alternative site, but the "unauthorized use" of the City-owned park property for the reservoir would require approval by public vote. While it appears to be a viable alternative site, Site 2 does not offer significant advantages compared to Site 1.

As an option, the existing Bolton Pump Station could be replaced with a new pump station located in a nearby area outside of the mapped ancient landslide, in Wildness Park along Clark Street. Relocating the pump station might also allow the vacated existing Bolton Site to be redeveloped for residential housing or other public uses.

Site 3 (Wilderness Park Property, East of Clark Street)

Site 3, identified on Figures 1 and 2, is located in Wilderness Park east of Clark Street, and is approximately 1,500 feet from the existing Bolton Reservoir site. The ground elevation ranges from approximately 350 to 460 feet, with ground sloping at approximately 20 percent in the vicinity of the proposed reservoir site. Approximately 2 to 3 acres of the park's 64.8 acres would be needed to accommodate construction of a buried or partially buried reservoir at this forested site. This would include the area needed for construction cut slopes, construction access to the base of the reservoir, and limited staging area. The Bolton Reservoir site or parking lot at Wilderness Park across the street could be an option for additional staging area if needed. A conceptual cross-section of the reservoir is illustrated in Figure 3.

It appears that construction and permanent site access could be provided from Clark Street. Compared to the nearby Site 2, alternative Site 3 would require additional water piping to

connect to existing infrastructure. To minimize depth of bury of pipelines serving this site, reservoir supply and discharge piping would need to be routed through an easement to the northeast across Wilderness Park instead of along Clark Street. This utility easement would likely also need to accommodate piping for site drainage and reservoir overflow. The existing Bolton Pump Station would be replaced with a new pump station located at Site 3, which is outside of the mapped ancient landslide. Relocating the pump station might also allow the vacated existing Bolton Site to be redeveloped for residential housing or other public uses. As shown on Figure 2, approximately 600 linear feet of water supply piping would be required to connect the proposed reservoir to the Bolton Pressure Zone piping at the intersection of Skyline Drive and Webb Street. An additional 1,900 linear feet of piping, routed through the park and along Skyline Drive and Skyline Circle, would be needed to connect the new Bolton Pump Station at Site #3 to the Horton Pressure Zone.

Site 3 is not located within the mapped boundary of the large ancient landslide identified and mapped by DOGAMI. Without additional geotechnical investigation, the geotechnical suitability of Sites 3 is unknown.

Siting the proposed reservoir in Wilderness Park is specifically considered to be a "nonauthorized use" of park property in accordance with Chapter XI, Section 46 of the West Linn City Charter, requiring the approval of the registered voters of the City of West Linn.

Based on conceptual budget level costs estimates, it appears that the cost of constructing the replacement reservoir at Site 3 would be similar to that of Site 2. Site 3 appears to be a technically and financially feasible alternative site, but the "unauthorized use" of the City-owned park property would require approval by public vote. Site 3 does not offer significant advantages compared to Site 1, except that it is outside of the ancient landslide, but its location in an undeveloped area of the park would result in greater park impacts.

Site 4 (High School Property)

Site 4, identified on Figures 1 and 2, is located at the forested western corner of the High School property. Ground elevations at this site range from approximately 340 to 420 feet, falling below the requirement for a ground level reservoir, with a slope of approximately 20 percent. Due to the lower ground elevation, an elevated reservoir would be required at this site. Approximately 2 to 3 acres of the school property would be needed to accommodate construction of the 4.0 MG elevated reservoir, or two 2.0 MG elevated reservoirs. This would include the area needed for construction cut slopes, construction access to the base of the reservoir, and staging area. The proposed elevated reservoir would be approximately 90 feet tall, and would have less useable storage than a ground level reservoir. A conceptual cross-section of the reservoir is illustrated in Figure 4.

It appears that construction and permanent access to Site 4 would need to be provided through a developed single family lot along Windsor Terrace. A nearby existing stream/riparian area identified on City GIS may cause further site and access constraints.

Reservoir supply and discharge piping would need to be routed through an easement to the west through school property since the higher ground elevations along Clark Street make installation of transmission piping unfeasible. The existing Bolton Pump Station would be replaced with a new pump station located at Site 4, which is outside of the mapped ancient landslide. Relocating the pump station might also allow the vacated existing Bolton Site to be redeveloped for residential housing or other public uses. Approximately 1,500 linear feet of water supply piping would be required to connect the proposed reservoir to the Bolton Pressure Zone piping at the intersection of Skyline Drive and Webb Street. An additional 4,500 linear feet of piping, routed through the park and along Skyline Drive, would be needed to connect the new Bolton Pump Station at Site #4 to the Horton Pressure Zone.

Site 4 is not located within the mapped boundary of the large ancient landslide identified and mapped by DOGAMI. Without additional geotechnical investigation, the geotechnical suitability of Sites 4 is unknown.

Based on conceptual budget level costs estimates, it appears that the cost of constructing the replacement reservoirs at Site 4 would be approximately 100 percent higher than Site 1 due to the high cost of constructing an elevated reservoir as opposed to a ground level reservoir. This alternative was designated as not viable due to the high cost and decreased usable storage of the elevated structure, and the need for acquisition of private property for access from Windsor Terrace. In addition, the existing nearby riparian area may cause site constraints, and the visual impact of a 90 foot tall 4.0 MG elevated reservoir would be significantly greater than a ground level reservoir.

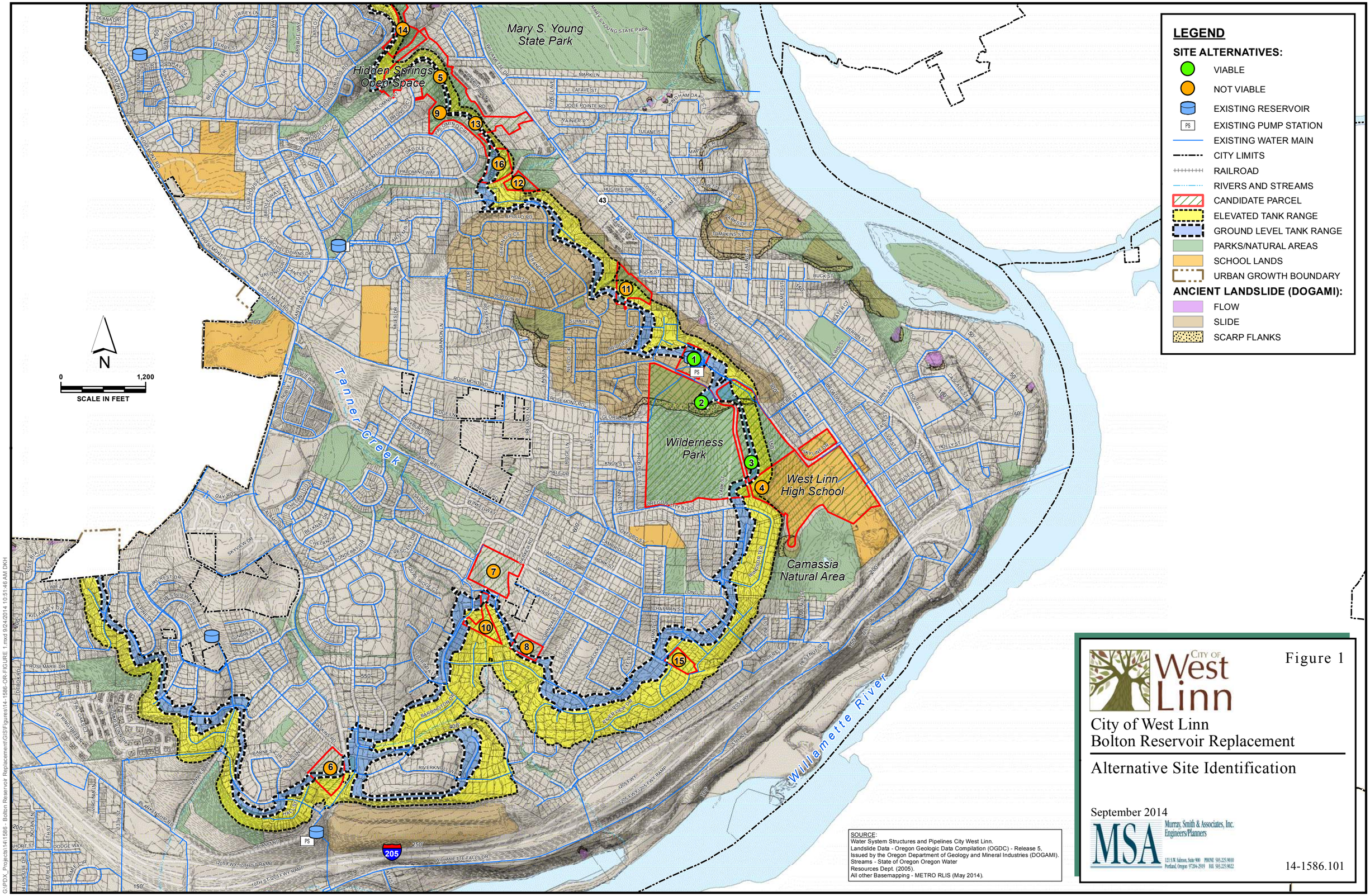
Conclusion

Based on the information available to complete this study, the preliminary siting analysis found that three sites could viably accommodate a 4.0 MG reservoir. The existing reservoir location, Site 1, appears to be the most suitable site. Site 2 was determined to be a viable alternative site, but does not offer significant technical advantages over Site 1 and is located within Wilderness Park, a City Charter protected park. Site 3 also appears to be a viable alternative site, but while it is located outside large ancient landslide mapped by DOGAMI, it is also located in the Charter protected Wilderness Park. Its location in the undeveloped area of the park would also result in greater park impacts.

Recommendations

Based on the results of the preliminary review presented above, it is recommended that the City take the following action:

Proceed with the geotechnical investigation and site specific seismic hazard study of Site 1 to confirm the geotechnical suitability of the site.


LEGEND
SITE ALTERNATIVES:
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NOT VIABLE
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EXISTING PUMP STATION
EXISTING WATER MAIN
CITY LIMITS
RAILROAD
RIVERS AND STREAMS
CANDIDATE PARCEL
ELEVATED TANK RANGE
GROUND LEVEL TANK RANGE
PARKS/NATURAL AREAS
SCHOOL LANDS
URBAN GROWTH BOUNDARY
ANCIENT LANDSLIDE (DOGAMI):
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SCARP FLANKS
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SCALE IN FEET
Mary S. Young State Park
Hidden Springs Open Space
Wilderness Park
West Linn High School
Camassia Natural Area
Tanner Creek
Willamette River
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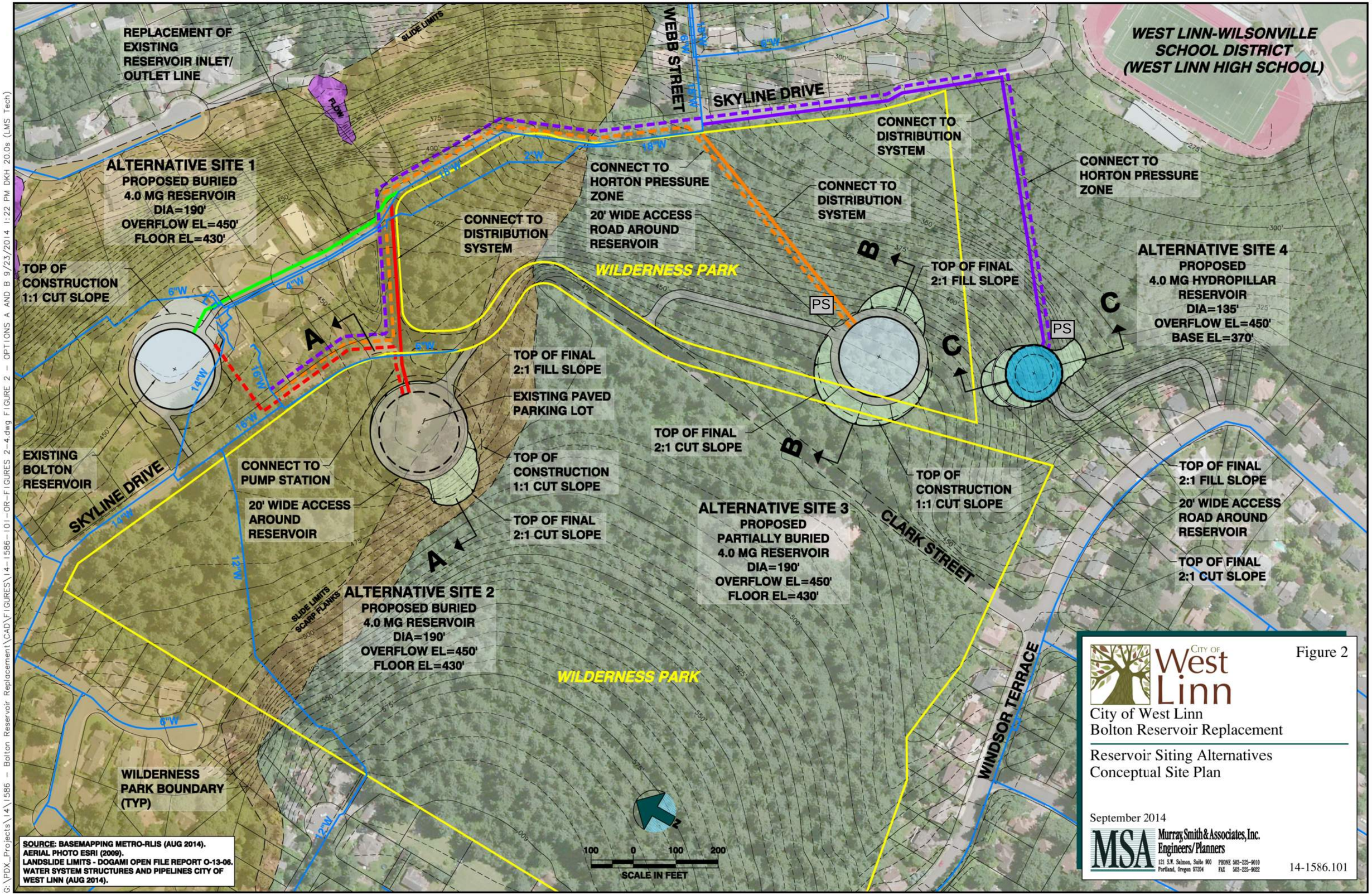
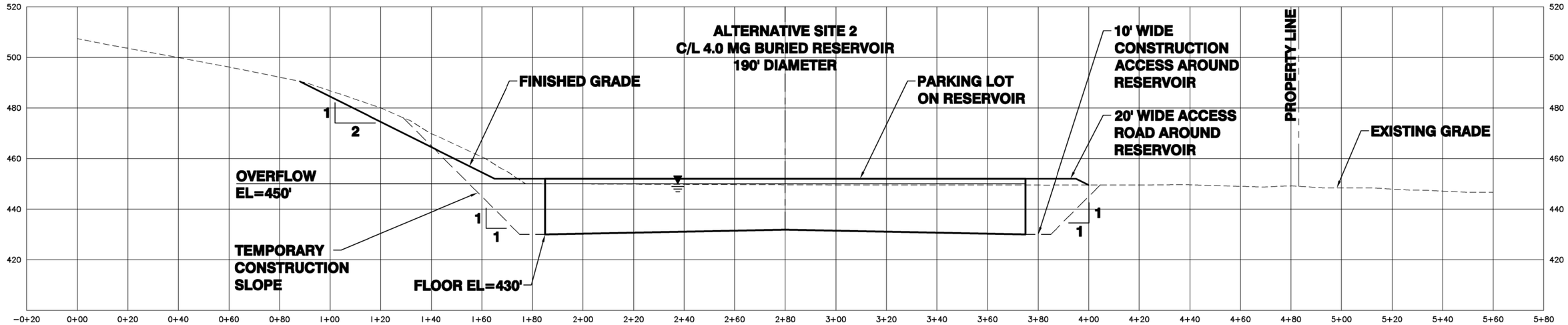
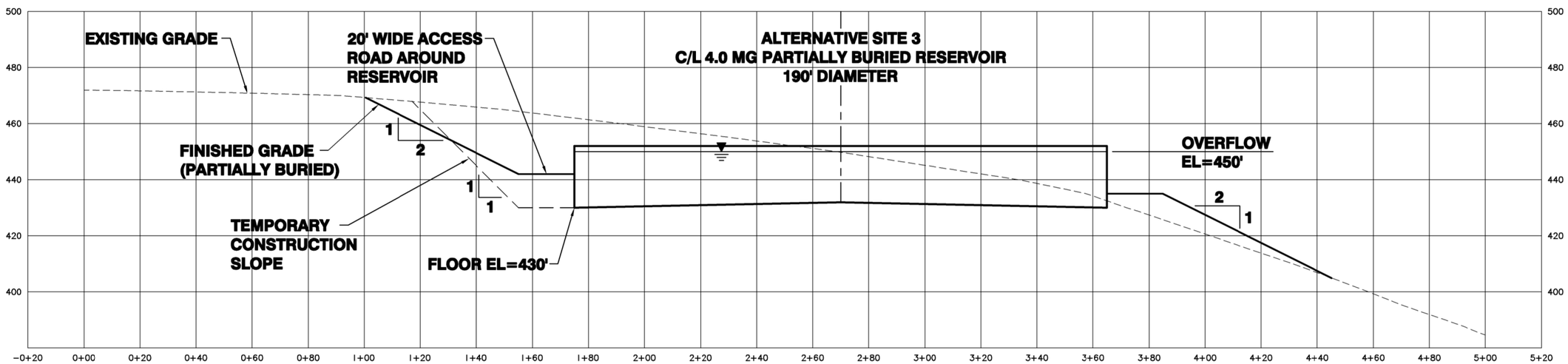
PS
SOURCE:
Water System Structures and Pipelines City West Linn.
Landslide Data - Oregon Geologic Data Compilation (OGDC) - Release 5, Issued by the Oregon Department of Geology and Mineral Industries (DOGAMI).
Streams - State of Oregon Oregon Water Resources Dept. (2005).
All other Basemapping - METRO RLIS (May 2014).
City of West Linn
Figure 1
City of West Linn
Bolton Reservoir Replacement
Alternative Site Identification
September 2014
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
14-1586.101
G:\PDX_Projects\141\586 - Bolton Reservoir Replacement\GIS\Figures\14-1586-OR-FIGURE 1.mxd 9/24/2014 10:51:46 AM DKH



G:\PDX_Projects\14\1586 - Bolton Reservoir Replacement\CAD\FIGURES\14-1586-101-OR-FIGURES 2-4.dwg FIGURE 2 - OPTIONS A AND B 9/23/2014 1:22 PM DKH 20.0s (LMS Tech)



SECTION A-A



SECTION B-B

City of West Linn

Figure 3

City of West Linn
Bolton Reservoir Replacement

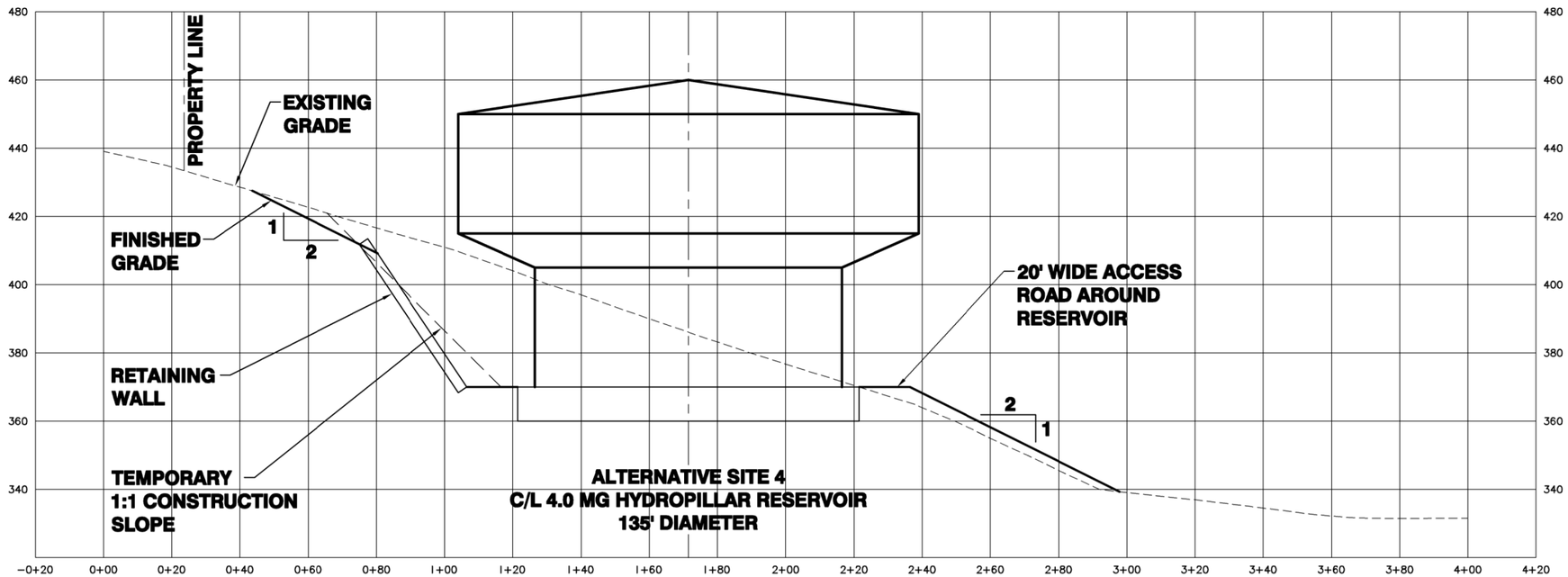
Reservoir Siting Alternatives
Conceptual Cross Sections A and B

September 2014

MSA Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900
Portland, Oregon 97204
PHONE 503-225-9010
FAX 503-225-9022

14-1586.101

G:\PDX_Projects\14\1586 - Bolton Reservoir Replacement\CAD\FIGURES\14-1586-101-OR-FIGURES 2-4.dwg FIGURE 3 - CROSS SECTIONS 9/10/2014 2:20 PM DKH 20.0s (LMS Tech)



SECTION C-C

Figure 4

City of West Linn
Bolton Reservoir Replacement

Reservoir Siting Alternatives
Conceptual Cross Section C

September 2014

Murray, Smith & Associates, Inc.
Engineers/Planners
121 S.W. Salmon, Suite 900
Portland, Oregon 97204
PHONE 503-225-9010
FAX 503-225-9022

14-1586.101

G:\PDX_Projects\14\1586 - Bolton Reservoir Replacement\CAD\FIGURES\14-1586-101-OR-FIGURES 2-4.dwg FIGURE 4 - CROSS SECTION 9/10/2014 2:21 PM DKH 20.0s (LMS Tech)

Table A-1
Bolton Reservoir Replacement Site Alternatives Evaluation

Site #	Site Address or Nearest Address	Owner(s) per Clackamas Couty Records	Existing Elevation Range	Tank Type	Existing Lot Size (acres, per GIS)	Current Use	Additional Piping Required (feet)	New Pump Station required?	Key Concerns							Conclusion / Notes	**Estimated Total Cost ($ M)**
									DOGAMI Mapped Ancient Slide or Flow	Requires Property or Easement Acquisition	WRA Conflict	Difficult Topography	Developed Single or Multi-Family Housing	Charter protected City Park or Open Space	High Cost		
1	6111 Skyline Dr.	City of West Linn	430' to 460'	Buried	3.23	Existing Reservoir & Pump Station	700	No	X							Viable - Favorable site, less unknowns. Within DOGAMI ancient slide.	**$9 M**
2	Wilderness Park, North parking lot	City of West Linn	440' to 450'	Buried	65	Park - Parking lot	1,150	No	X					X		Viable - In Wilderness Park, a Charter protected park. Within DOGAMI ancient slide.	**$11 M***
3	Wilderness Park, East of Clark St.	City of West Linn	320' to 470'	Ground	65	Park	2,500	No				X		X		Viable - In Wilderness Park, a City Charter protected park. Steep slope. Cost includes relocating Bolton Pump Satation to Site #3.	**$13 M**
4	5464 West A St. & 5281 Windsor Terr. site access	West Linn-Wilsonville School District #3J	300' to 370'	Elevated	31.56	High School (Vacant Forrested) & Single Family Residence	6,000	No		X	X	X	X		X	Not Viable - Ground elevation requires 90' elevated tank and retainging wall. Access across existing parcel with single family home. Potential WRA Conflict with drainage basin/riparian area. Cost includes relocating Bolton Pump Station to Site #4. High cost.	**$22 M**
5	Hidden Springs Open Space near 20001 Larkspur Ln. & Private parcel near 3600 Mohawk Way	City of West Linn & Private	320' to 530'	Ground	8.28 & 4.31	Open Space & Vacant	16,000	Yes		X	X	X		X	X	Not Viable - Significant new infrastructure required - pipeline & pump station. WRA Conflict with creek/riparian/drainage basin area. Located in City Charter protected Open Space. Very steep slope. Property acquisition required. High cost.	**$19 M**
6	3200 S Haskins Rd.	Private	400' to 470'	Ground	4.66	Single Family Residence / Forrested	13,000	Yes		X		X	X		X	Not Viable - Significant new infrastructure required - pipeline & pump station. Property acquisition required - existing single family home, outside of City Limits. Site is remote relative to the Bolton Pressure Zone which may present water quality problems and challenging pipeline alignment with I-205 Hwy crossing. High cost.	**$16 M**
7	4340 S Parker Rd.	Private	460' to 500'	Ground	7.13	Vacant	6,000	Yes		X	X				X	Not Viable - Ground elevation is too high - excessive excavation & retaining wall. Significant new infrastructure required - pipeline & pump station. Property acquisition required. WRA Conflict with creek/riparian area. High cost.	**$14 M**
8	4096 Cornwall St.	Private	450' to 490'	Ground	2.17	Vacant	5,000	Yes		X		X			X	Not Viable - Ground elevation is too high - excessive excavation & retaining wall. Property acquisition required. Significant new infrastructure required - pipeline & pump station. Steep slope, constrained site. High cost.	**$14 M**
9	Near 19701 Hidden Springs Rd.	City of West Linn	430' to 470'	Buried	6.83	Open Space	3,500	Yes			X	X		X	X	Not Viable - Significant new infrastructure required - pipeline & pump station. WRA Conflict with creek/riparian/drainage basin. Located in City Charter protected Open Space. Very steep slope. High cost.	**$13 M**
10	Near 2688 Beacon Hill Dr.	Tanners Stonegate Homeowners	380' to 390'	Elevated	2.73	Drainage	8,500	Yes		X	X	X		X	X	Not Viable - Significant new infrastructure required - pipeline & pump station. WRA Conflict with creek/riparian/drainage basin. Property acquisition from HOA. Constrained site. High cost.	**$21 M**
11	Near 2300 Hammerle St.	City of West Linn	350' to 420'	Elevated	3.86	Open Space	2,000	No	X		X	X		X	X	Not Viable - Significant new pipeline infrastructure required. WRA Conflict with creek/riparian/drainage basin. Located in City Charter protected Open Space. Within DOGAMI ancient slide. Steep slope. High cost.	**$17 M***
12	Near 2701 Pimlico Dr.	City of West Linn	330' to 410'	Elevated	1.75	Open Space	3,250	Yes			X	X		X	X	Not Viable - Significant new infrastructure required - pipeline & pump station. WRA Conflict with creek/riparian/drainage basin. Located in City Charter protected Open Space. Steep slope. High cost.	**$19 M**
13	Near 20130 Larkspur Ln.	Private	260' to 470'	Elevated	4.07	Vacant	3,500	Yes		X		X			X	Not Viable - Significant new infrastructure required - pipeline & pump station. Property acquisition required. Very steep slope, constrained site. High cost.	**$20M**
14	Near 19300 Hidden Springs Rd.	City of West Linn	320' to 450'	Elevated	3.92	Open Space	4,000	Yes			X	X		X	X	Not Viable - Too Steep. Significant new infrastructure required - pipeline & pump station. WRA Conflict with creek/riparian/drainage basin. Located in City Charter protected Open Space. High cost.	**$20 M**
15	2111 Sunset Ave.	Private	390' to 420'	Elevated	1.94	Developed / Multi-Family Housing	7,250	No		X		X	X		X	Not Viable - Property acquisition - Existing Multi-family housing. .Significant pipeline infrastructure required. High cost.	**$20 M***
16	Near 2600 Pimlico Dr.	Springcrest Condos	410' to 440'	Elevated	2.70	Developed / Multi-Family Housing	3,250	Yes		X		X	X		X	Not Viable - Property acquisition - Existing Multi-family housing. Significant new infrastructure required - pipeline & pump station. High cost.	**$23 M**

Notes:
1. Existing lot sizes per GIS data.
2. Estimated Total Cost includes construction cost for reservoir, piping and pump station as needed, plus contingency, and estimated allowances for property acquisition, engineering, permitting, construction management and City administration. Estimated Total Costs are conceptual budget level costs intended to provide a relative cost comparison between site alternatives.
3. WRA Conflicts include potential conflicts with water resource areas including wetlands, flood plains, streams and riparian areas, per CDC Chp. 32 and identified per City GIS
4. Parks and Open Space identified per City GIS

* Add $1.7 M to the Estimated Total Cost for the option to relocate the existing Bolton Pump Station.