Site Visit and Conceptual Design Study

Roanoke River Park

Roanoke, Virginia

December 8, 2015

Prepared for:

Pete Eshelman
Roanoke Regional Partnership
111 Franklin Plaza, Suite 333
Roanoke, VA, 24011

Prepared by:

Scott Shipley, P.E.
S2o Design and Engineering
318 McConnell Drive
Lyons, CO, 80540

Introduction:

There is interest in Roanoke Region of Virginia to create a river park that will function as a community riverside park and that will provide a venue for rafting, whitewater kayaking, tubing and other healthy, active, outdoor recreational activities. River sports are some of the fastest growing sports in America and there is a growing trend among many towns and cities to create these parks in their own backyards. River parks, often surrounded by trails and recreational areas, not only achieve their original goal of attracting paddle sports enthusiasts, but often exceeded these expectations by becoming focal points of their communities and destinations for outdoor recreation-based tourism from throughout the region. These parks often play host to major events centered on slalom or freestyle competitions or to community celebrations such as river festivals. In addition, river parks can have a significant economic impact on the local community, as visitors spend money at local restaurants, hotels, and retail establishments. Some cities, like Golden, Colorado; and Reno, Nevada have reported impacts on the local economy, from tourism generated by the park, on the order of millions of dollars per year.

The Roanoke Regional Partnership has commissioned a study to investigate the preliminary feasibility of creating a River Park in Roanoke County near the City of Roanoke Virginia and to begin the process of conceptualizing possible design solutions that meet project objectives. This report summarizes the findings of that study.

Section 1: Site Information

Four sites have been selected in the Roanoke area for preliminary analysis regarding the feasibility of creating whitewater park improvements in these areas. The proposed project sites are located in the Roanoke River at the Mill Lane Bridge, Wasena Park, the Explore Park Site, and in Tinker Creek at the Old Mill Site. Prior to planning park features in this area it is important to understand the economic, cultural, physical and regulatory environment in which the proposed projects will be built.

Roanoke Metropolitan Area

The Roanoke Metropolitan Area is the economic and cultural hub of Southwest Virginia. Due to its central location, it acts as a distribution center for much of the surrounding region. Roanoke is home to both the Taubman Museum of Art and the Virginia Museum of Transportation. Salem is home to Roanoke College, a private four year liberal arts college. Numerous major regional thoroughfares including Interstate 81 (I-81), U.S. Route 221 (US 221), and U.S. Route 220 (US 220) are found nearby. The Roanoke Regional Airport serves as a hub for both passenger and cargo air traffic within the region.

The Cities of Roanoke and Salem are bisected by the Roanoke River as it follows the Roanoke River Valley, located in the heart of Virginia's Blue Ridge Mountains. The region is home to destination kayaking rivers such as the James, New, and Roanoke Rivers along with numerous other smaller rivers and creeks. Major population centers, such as Richmond, VA; Greensboro, NC; and Charlotte, NC are all within 2-3 hours' drive. Figure 1 illustrates the location of the City of Roanoke within the State of Virginia.

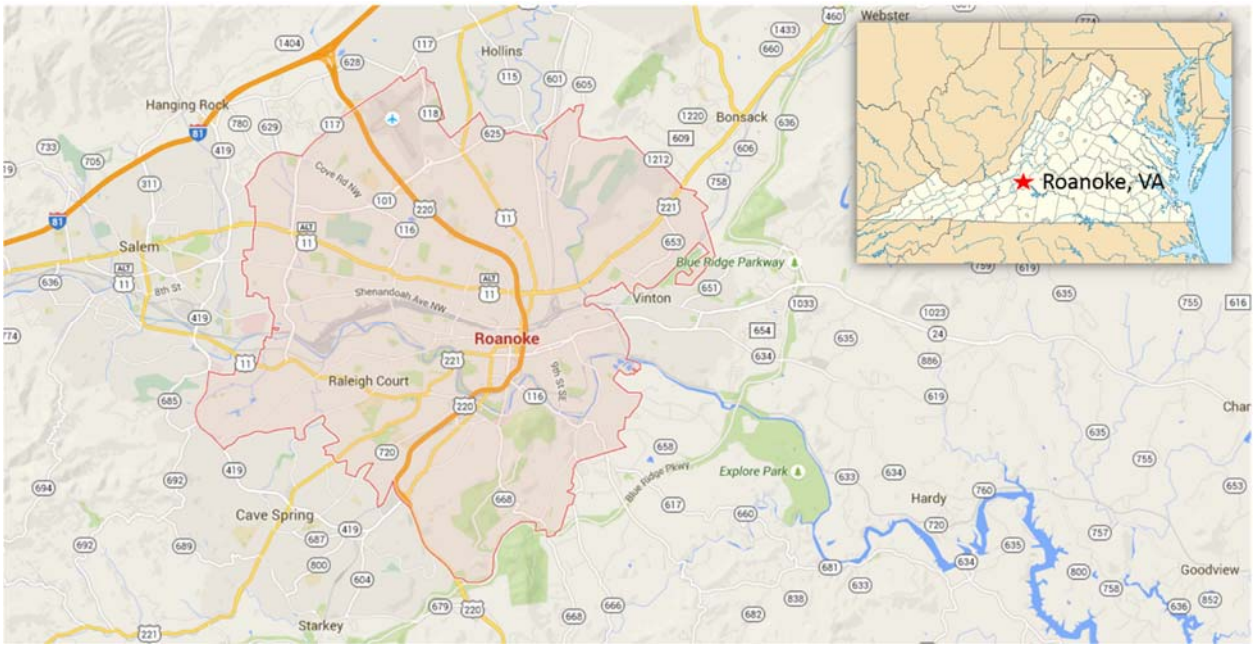

Figure 1: Location Map for Roanoke, VA

The City of Roanoke is the largest municipality in Southwest Virginia, with an estimated population of 99,428 people in 2014 (US Census Bureau, Roanoke City Virginia, 2015). The larger Roanoke Metropolitan Statistical Area (MSA) is composed of the independent cities of Roanoke and Salem along with Botetourt, Craig, Franklin, and Roanoke counties, is a little larger with a population of approximately 308,707 people (US Census Bureau, Roanoke Metropolitan Statistical Area, 2015).

Hydrology

Flood flows in the Roanoke River and Tinker Creek are substantial. However, more typical flows in both drainages are significantly smaller. Since the timing and magnitude of available flows are key factors in the overall potential of a river park, the hydrology of the project sites has been analyzed to identify target flow rates for each site that balance both the magnitude and duration of the recreational experiences sought.

To characterize stream gaging data, collected near three of the four project sites, the median of the mean daily flows was selected. More typically, averages are used to describe the central tendency of the hydrology of a potential site. However, due to the extreme magnitude of flood events relative to more typical flows observed in the channels, median values are assumed to be more representative of the recreational flows anticipated during the season of use for each project site. An analysis of the hydrographs at these four sites reveals average flows that reach the area of roughly 300 cfs for the Mill Lane Site, roughly 500 cfs for the Wasena Park Site, and roughly 600 cfs for the Explore Park site during higher flows, with peak averages being slightly higher. Tinker Creek flows are in the 150 to 200 cfs region.

In comparison to the majority of river parks in existence today, the typical flow rates at the four project sites are on the lower end of the spectrum. In general, river parks typically provide a competition-level whitewater experience, in a comparable river channel, at flows approaching 1000 cfs or greater. The

statistical analysis above is intended to describe anticipated typical conditions, however, it does not explicitly describe annual or even seasonal peak flows at each project site. These more fleeting high flows can be expected less often during more extreme rainfall events. During these periods the recreational experiences of the river parks will increase substantially, offering potentially competition level whitewater for the duration of the runoff event. Though expert level whitewater may only be available at each park for a portion of each year, recreational opportunities including surfing, spinning, rec paddling, tubing, slalom, skills training, as well as paddle-through recreation will still be available seasonally to varying degrees at each potential site. A detailed hydrograph is shown for each site in the site profiles section below.

Flooding

The Roanoke County Flood Insurance Study (FIS) was reissued on September 28, 2007 to reflect revised and updated Flood Insurance Rate Maps (FIRM) for Roanoke County Virginia: Including the independent Cities of Roanoke and Salem; the Town of Vinton; and the unincorporated areas of Roanoke County (Federal Emergency Management Agency, 2007). Flooding within the City of Roanoke is principally based around the Roanoke River and Lick Run floodplains; however, the central business district is also subject to flooding from Tinker Creek. Within the City of Salem, severe flooding is centered on the Roanoke River floodplain, where hundreds of structures along Riverside Dr, Front St, and Bowman St are located within the 100 year floodplain (FEMA's National Flood Hazard Layer (Official), 2015).

According to the FIS the 1% annual chance floods (100 year flood) for the four project site locations are as follows:

- Mill Lane, 34,600 cubic feet per second (cfs) for the Roanoke River upstream of Peters Creek;
- Wasena Park, 35,600 cfs for the Roanoke River at USGS Gage 02055000;
- Explore Park, 43,500 cfs for the Roanoke River upstream of Back Creek; and
- Tinker Creek, 17,800 cfs for Tinker Creek at Mason Mill Rd.

Detailed flood studies have been performed for all portions of the Roanoke River and Tinker Creek, within Roanoke County. Proposed changes to the existing channel geometries will require coordination with FEMA to either demonstrate no-rise to the effective Base Flood Elevations (BFE) or to revise FIRMs to reflect changes in 100 year flooding before and following construction activities.

Historic Structures in Roanoke County

The Cities of Roanoke and Salem have rich histories that dates back to the turn of the 19th century, while agricultural activity in the region dates back to the mid-18th century (History of the City of Roanoke Virginia, 2015). Prior to white settlers Native American groups established numerous settlements throughout Virginia's Blue Ridge Mountains.

A preliminary review of the areas surrounding the four proposed project sites, for historic properties listed on the National Register of Historic Places, was conducted using the National Park Services geospatial dataset (National Park Service , 2015). Only the Wasena Park site was found to have the following listed historic properties in the vicinity of the project site:

- Roanoke Apartments (06000759); and
- Mountain View (80004221).

A map describing the location of the project site relative to the two properties list on the National Historic Register is provided in Figure 2.

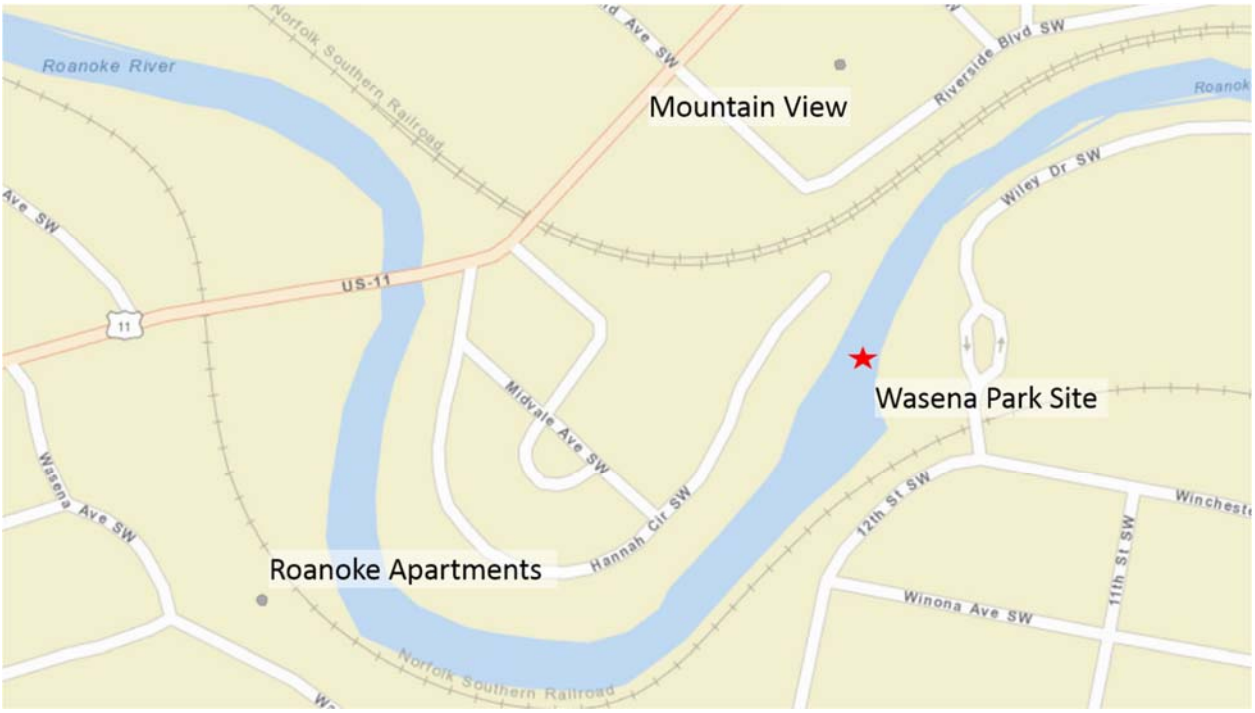

Figure 2: Map showing approximate location of the Wasena Park project site relative to the Roanoke Apartments and Mountain View historic properties.

A complete archeological assessment of all of the proposed project sites, to determine impacts to listed and eligible sites on the National Register of Historic Places, may be required prior to receiving 404 authorization to build the river parks. Though this assessment typically has little impact on in-channel river parks, the project owner should be aware of this requirement as it could result in significant delays and/or costs to a potential project if impacts to historical or culturally significant resources are identified.

Endangered Species in Roanoke County

All federally listed species identified within the immediate project areas, as described by the U.S. Fish and Wildlife Service, are shown in Table 1.

Table 1: Listed species within the project areas of Roanoke County.

GROUP	COMMON NAME	SCIENTIFIC NAME	STATUS
Clams	James spinymussel	Pleurobema collina	Endangered
Fishes	Roanoke logperch	Percina rex	Endangered
Flowering Plants	Smooth coneflower	Echinacea laevigata	Endangered
Mammals	Indiana bat	Myotis sodalis	Endangered
Mammals	Northern Long-Eared Bat	Myotis septentrionalis	Threatened
Migratory Birds	Bald Eagle	Haliaeetus leucocephalus	Bird of Conservation Concern
Migratory Birds	Black-billed Cuckoo	Coccyzus erythropthalmus	Bird of Conservation Concern
Migratory Birds	Blue-winged Warbler	Vermivora pinus	Bird of Conservation Concern
Migratory Birds	Fox Sparrow	Passerella iliaca	Bird of Conservation Concern
Migratory Birds	Golden-winged Warbler	Vermivora chrysoptera	Bird of Conservation Concern
Migratory Birds	Kentucky Warbler	Oporornis formosus	Bird of Conservation Concern
Migratory Birds	Loggerhead Shrike	Lanius ludovicianus	Bird of Conservation Concern
Migratory Birds	Louisiana Waterthrush	Parkesia motacilla	Bird of Conservation Concern
Migratory Birds	Pied-billed Grebe	Podilymbus podiceps	Bird of Conservation Concern
Migratory Birds	Prairie Warbler	Dendroica discolor	Bird of Conservation Concern
Migratory Birds	Red-headed Woodpecker	Melanerpes erythrocephalus	Bird of Conservation Concern
Migratory Birds	Rusty Blackbird	Euphagus carolinus	Bird of Conservation Concern
Migratory Birds	Wood Thrush	Hylocichla mustelina	Bird of Conservation Concern
Migratory Birds	Worm Eating Warbler	Helmitheros vermivorum	Bird of Conservation Concern
Migratory Birds	Yellow-bellied Sapsucker	sphyrapicus varius	Bird of Conservation Concern

In addition, the Central Appalachian Focus Area encompasses three watersheds in the region, including the Upper Roanoke River Watershed, which are known to contain high concentrations of rare species. Within these three watersheds a total of 31 endangered, 8 threatened, 6 candidate, and 140 federal species of concern were identified, along with Critical Habitat designations for 7 species within this focal area, and 4 species identified as Brink Species (either on the brink of extinction or recovery) (U.S. Fish and Wildlife Service, Virginia Field Office, 2015).

Additional assessments of the sites and impacts to these species may need to be conducted during the preliminary design/permitting stages of the project. Additional consultation with the U.S. Fish and Wildlife Service is anticipated, once the final project sites are selected, to ensure that they do not include known populations or critical habitat for federally listed species and/or additional species of concern within the project areas. If critical habitats are identified, the project will need to work with Fish and Wildlife to determine if the project, in design or implementation, can minimize impacts in an acceptable manner.

Typical Economic Impacts of River Parks

The economic impacts of the proposed parks could have a significant impact on decision maker's choice in funding a particular park. Many river parks, built in similar towns and settings throughout the United States, have become significant tourist attractions. These parks bring enthusiasts and spectators alike to their respective communities, and create measurable economic impacts through increased property values, direct spending at the site, and tourism dollars spent at local restaurants, hotels, and businesses.

A river park like the ones proposed in the greater Roanoke area can attract tourists and generate total economic impacts on the order of hundreds of thousands of dollars per year. In-stream river parks located in Colorado have had impacts as high as $7-9 million dollars per year. Table 2, shown below, illustrates some typical economic impacts of these parks:

Table 2. Economic Impacts of River Parks (per year in US Dollars) (Multiple sources)

Economic Impacts of River Parks

River	Location	User Days	Additional Spending	Total Impacts (Millions)
Clear Creek	Golden, CO	13,000-14,000	$910,000-$1.1 Million	$1.3-2.2 Million
Blue River	Breckenridge, CO	1,200-2,300	$220,000-$460,000	$0.4-$1.1 Million
Gore Creek	Vail, CO	1000-2,300	$3.5 Million	$3.5-$4 Million
Sacandaga River	Saratoga/Warren County, NY	17,600-25,400	$1.8-$2.8 Million	$2.3-$3.7 Million
Cuyahoga River	Kent, OH	10,000-40,000	$200,000-$800,000	$0.5-$1.7 Million
Yampa River	Steamboat Springs, CO	75,700	$4.9 Million	$7.2 Million

The impacts of these parks are diverse and are based on regular usage of the River Park, as well as instructional programs, competitions, festivals, and other recreational events. Freestyle events like those that occur weekly in Colorado during spring runoff, can bring millions of dollars into the local economy on a single weekend alone. For example, the GoPro games in Vail, CO reported an economic impact of $4.7 million dollars in 2013 (Wong, 2014). In addition to creating economic impacts, these events also help to market a particular community as an outdoor town and whitewater destination.

Project Site Locations

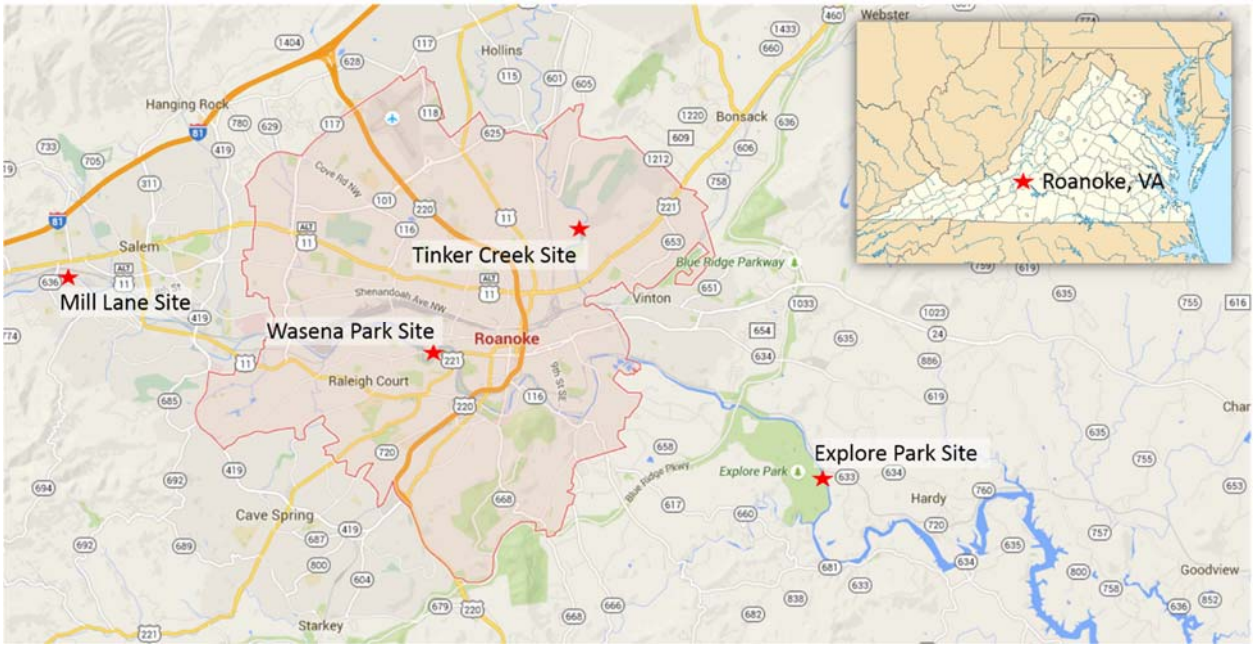

Figure 3: Proposed project locations near Roanoke, VA

Four separate sites have been identified for conceptual design. Three of these sites are located along the Roanoke River and one site is located on Tinker Creek. The Mill Lane Site is the upstream-most site on the

Roanoke River. It is accessed via West Riverside Dr off Mill Lane in Salem, VA. The Wasena Park site is located approximately 8.5 miles downstream of the Mill Lane site on the Roanoke River. Access to this site is achieved via Winchester Ave off Main St in Roanoke, VA. The Explore Park site is located adjacent to the Explore Park site on the Roanoke River. It is accessed via the Roanoke River Parkway off the Blue Ridge Parkway in Roanoke County. The Tinker Creek site is located approximately 3 miles upstream from the confluence of Tinker Creek and the Roanoke River. Access to this site is achieved via Mason Mill Rd off Hollins Rd in Roanoke, VA.

The Mill Lane Site

Figure 4: The Mill Lane Site as seen looking downstream from the Mill Lane Bridge

Existing Conditions

The Mill Lane Site is located in a relatively steep reach of the Roanoke River just downstream of the Mill Lane Bridge. There is an adjacent parking area situated just upstream of the bridge on the South Side of the river. Access and a put-in could be created at this location however the Mill Lane Bridge is a low-to-the-river structure that could present a hazard to navigation at higher flows. It may be a better course of action to design access and parking downstream of the bridge. Construction of this access would be dependent on permission from current property owners.

The river is divided downstream of the bridge by a low riparian area. The river right (southern) channel is the primary channel with the northern channel functioning as an overflow channel. Flows converge halfway through the rapid and form a single thread for the remaining portion. The rapid is followed by a low slope section of the river for a couple hundred yards with an existing take-out and parking area located along the river trail at this location. Users at the site could potentially put in on the City put-in, navigate to this point, and then return to the put-in via this point of egress. The specific location and layout of the site is shown below in Figure 5:

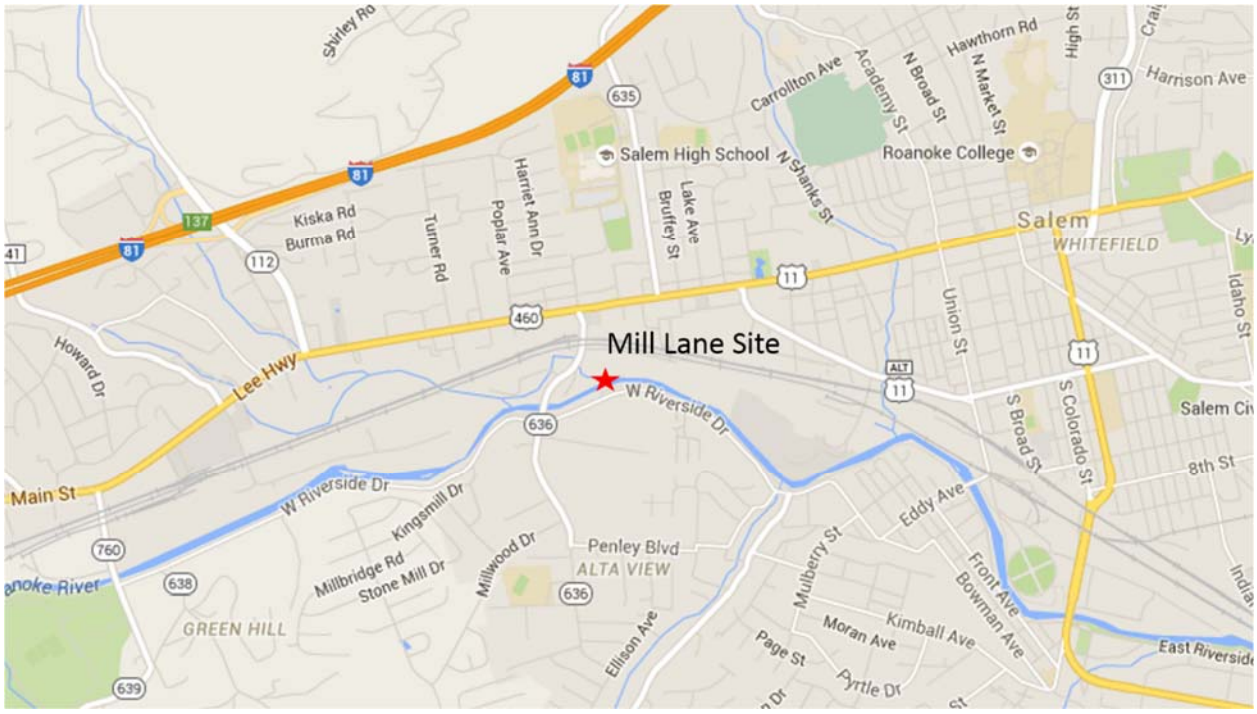

Figure 5: The Mill Lane site is located downstream of the Mill Lane bridge crossing the Roanoke River near its intersection with West Riverside Dr.

Land Ownership

The Mill Lane site is somewhat problematic with regards to land ownership. Portions of the site are located on private property (Figure 6). Additional adjoining land owners (Table 3) include the City of Salem and Robert Dooley of Roanoke, VA (City of Salem - Real Estate Application, 2015). Numerous other private holdings are also found in the vicinity of the project site, though none directly abut to lands on which the project is proposed.

Ownership and easements were not able to be attained in this reach for the river corridor trail suggesting that construction and access easements for the site could be problematic. There is river access at the site via parking upstream of the Mill Lane Bridge and, if there is clearance under the Mill Lane Bridge, adequate float access to the river downstream of the bridge. There is also a municipal take-out just downstream of the property. There is a right to float navigable waterways in the United States, however, construction of a whitewater park will require written permission from all landowners of the site. Figure 6, shown below, shows land ownership at the site:

Figure 6: Aerial Imagery of the Mill Lane project site, showing adjacent land ownership (City of Salem - Real Estate Application, 2015).

Table 3: Land ownership adjacent to the Mill Lane project site (City of Salem - Real Estate Application, 2015).

TAX MAP NUMBER	OWNER	MAILING ADDRESS
165 - 3 -1 -	PRICE DAVID L & PRICE ANN S	1263 W RIVERSIDE DR SALEM, VA 24153
140 - 3 -1 -	CITY OF SALEM	PO BOX 869 SALEM, VA 24153
165 - 2 -2 -	CITY OF SALEM	PO BOX 869 SALEM, VA 24153
165 - 3 -2 -	DOOLEY ROBERT P JR	8177 WOOD HAVEN RD ROANOKE, VA 24019

Flows at the Mill Lane Site

An annual hydrograph describing the median of mean daily flows at the project site is shown in Figure 7. The Figure shows the anticipated seasonal flows for the proposed project site.

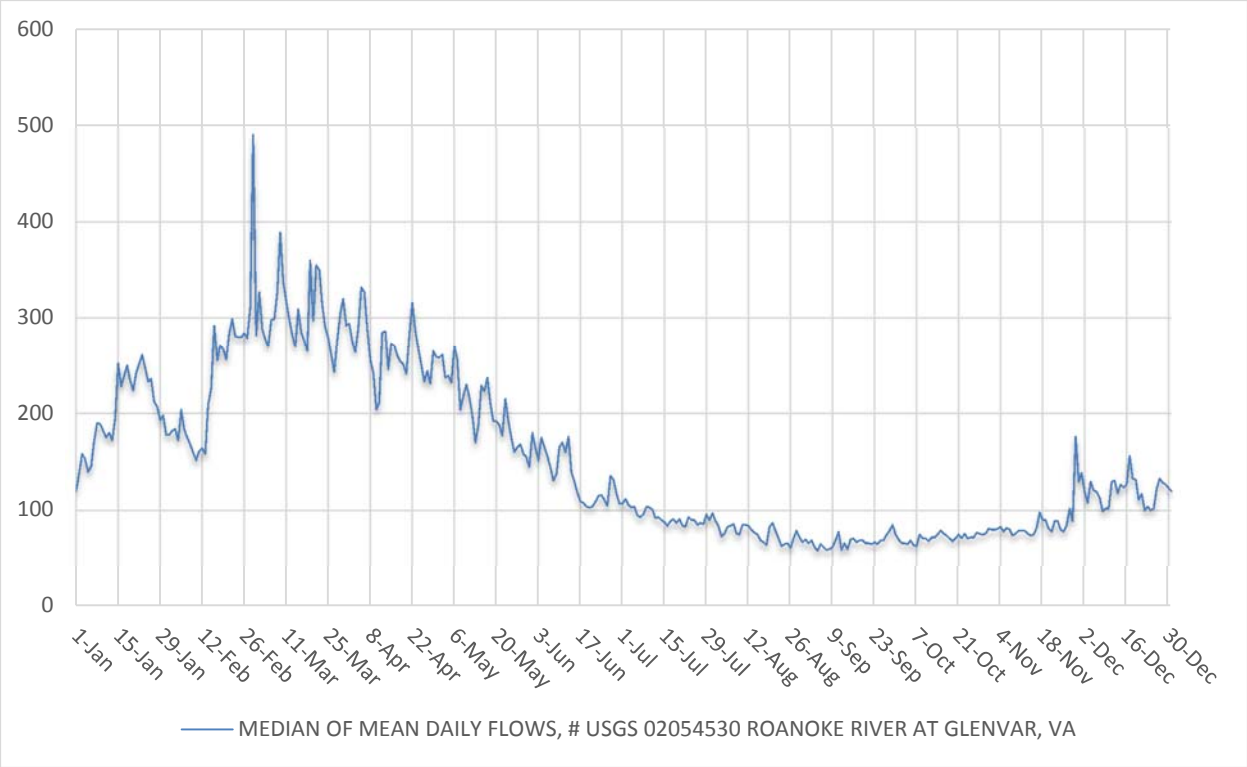

Figure 7: Median of mean daily flows in the Roanoke River upstream of the Mill Lane site.

The seasonal flows at this site would deliver a family friendly float park experience. Typical float parks feature flows between 100-300 cfs and are good for beginner kayaking, tubing, and float trips. Peak flows at this location are in the range of 300-400 cfs and average summer flows are at, or near 100 cfs. Freestyle events and national level slalom events tend to be held at flows of 700 cfs or higher. The park can be designed to be fun for all types of general users at low flows and for whitewater enthusiasts to pursue advanced kayaking at the site during high flow events such as rainstorms.

Figure 8, shown below, shows yearly peak flows at the site. Peak flows in the watershed are very high with regular flood events on the order of 15,000 cfs to 20,000 cfs. At these flow rates the river and proposed structures would be inundated but on lower flooding events, events in the range of 1,000 cfs to 3,000 cfs, the park would create regionally attractive whitewater that would draw boaters from throughout the region.

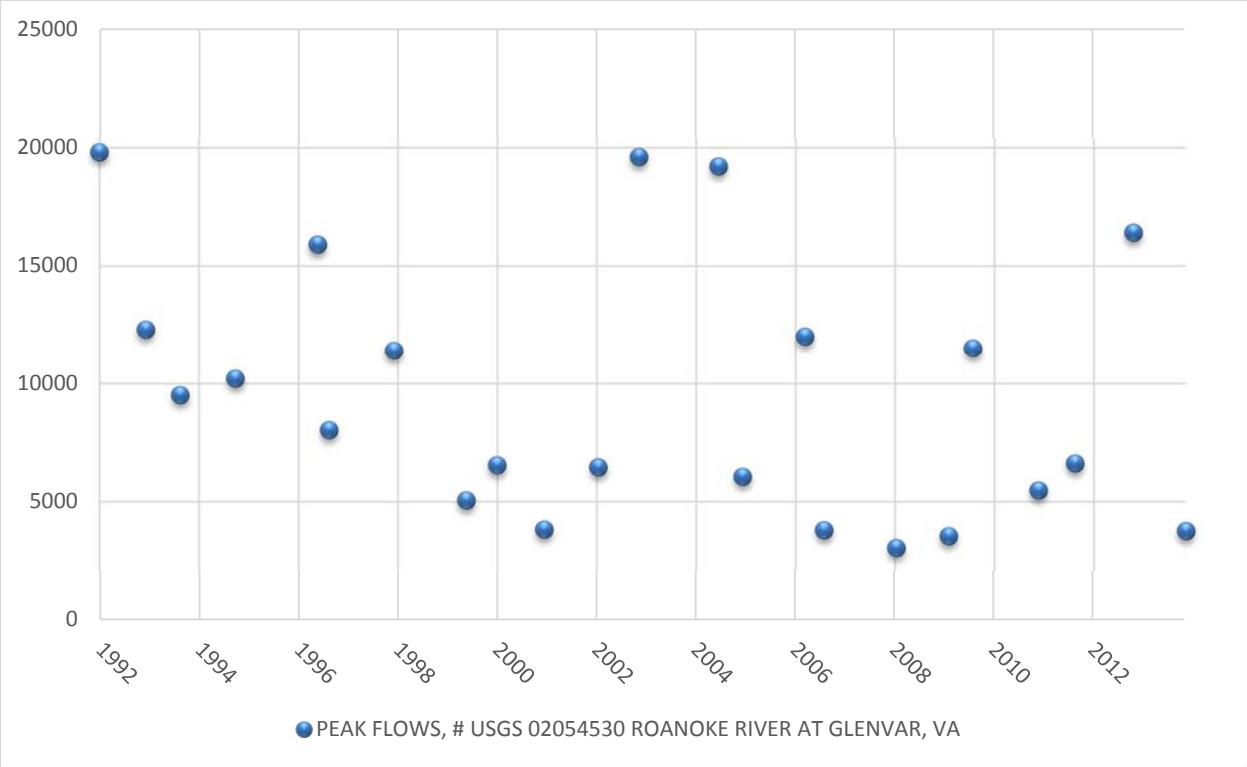

Figure 8: Peak flows measured in the Roanoke River upstream of the Mill Lane site.

Flood Impacts

Whitewater Parks are constructed to meet all Federal, State, and Local flood codes and are designed using flood modeling software approved by the US Army Corps of Engineers. These river Parks can typically be designed to a "no-rise" condition, which ensures no impact during the 1% chance annual flood (100 year flood) to neighboring properties or changes to existing flood hazard zoning and associated flood insurance requirements. This condition requires that proposed changes within 100 year floodplain create no net increase in modeled water surface elevations during the 100 year base flood. Base Flood Elevations (BFE) are used to define effective water surface elevations at sites where detailed flood studies have been performed.

A requirement of the National Flood Insurance Program is that a proposed project can create no-net-negative-impact to insurable structures. This requirement is particularly robust in the regulatory floodway.

The configuration of this site substantiates the need for a project designed to meet a no-rise requirement. The challenge in this instance will be to find a design that focuses flows and energy at lower flows (by consolidating drop at average flows) but that does not cause a rise at higher flows.

Figure 9 describes the regulatory floodway, 100 year floodplain, 500 year floodplain, calculated BFEs, and associated flood hazard zoning at this project site:

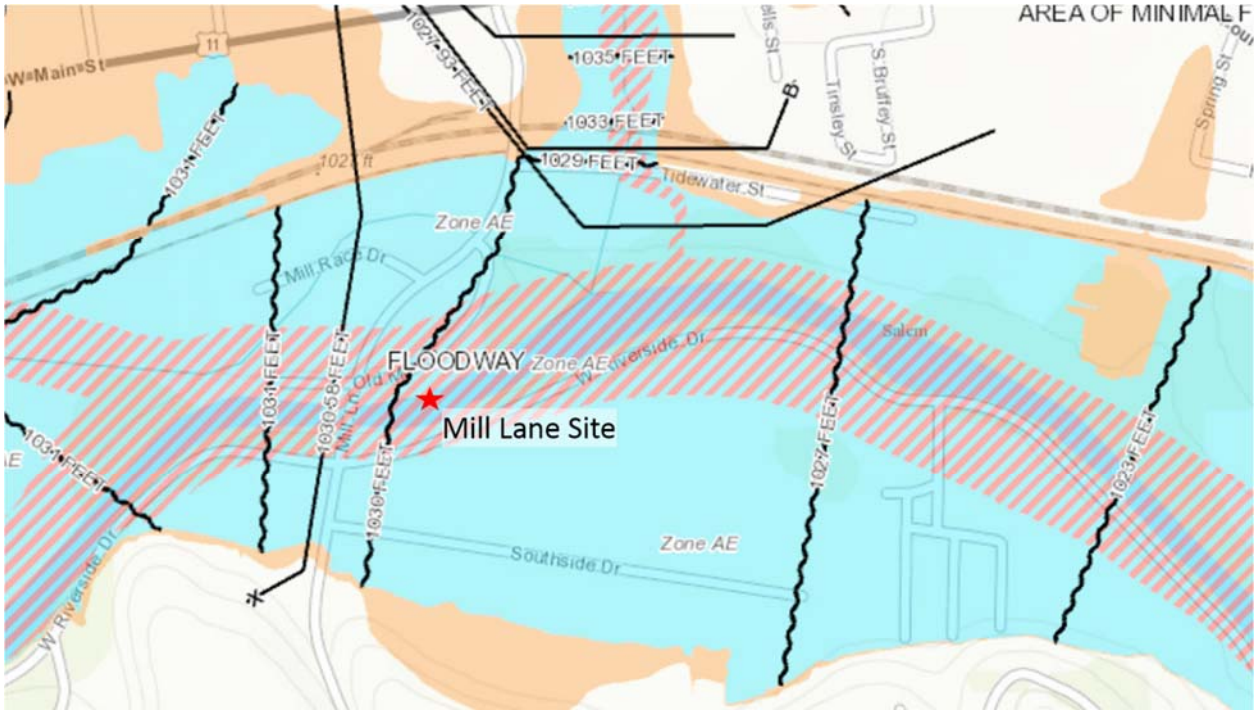

Figure 9: FEMA Flood Hazard Mapping for the Mill Lane project site (FEMA's National Flood Hazard Layer (Official), 2015).

The floodplain at this site is extensive with an active floodway mapped that is well outside the typical riverbed and, in fact, crosses Riverside Drive in this case. There are numerous residential and commercial structures that are currently found within the 100 year floodplain. Improvements at this site are limited to those improvements that can be implemented with no net negative impact to the 100 year floodplain.

Historic Structures

There are no historic structures found to be located in the vicinity of the Mill Lane Site.

Mill Lane Site Conceptual Design

The Proposed design for the Mill Lane site is shown below in Figure 10:

Figure 10: The conceptual design for the Mill Lane Site

The Mill Lane Conceptual Design features put-ins both above the Mill Lane Bridge (for lower water) and below (for higher water). The upper drop structure is designed to maintain the separation of flows between the main channel, on the true right and the overflow channel, on the true river left. A series of deflectors from both the river left and right will create eddies and wave features (at higher water) and will also serve to center the river's flows at lower flows. Below the island the flows from each channel will coalesce and the river will pour over a central drop structure that will create the park's first drop that utilizes the entire flows of the Roanoke River. A second drop structure is located downstream near the take-out that again utilizes the full flow of the Roanoke River. A number of random boulders will be included. Random boulders will be 6'-8' in diameter and will create added eddies and features. These rocks will help to tune the Whitewater Park and will also add recreation and aesthetic value to the park.

Opinion of Probably Costs for the Mill Lane Site

The conceptual level cost estimates for the Mill Lane Site are shown below:

Table 4: Conceptual level cost estimates for the Mill Lane Site

Project: Roanoke Whitewater Park
Issue Date: 9/29/2015
Developed By: DW

Mill Lane: Estimated Design and Construction Costs

Description	Quantity	Unit	Unit Cost	Item Total Cost
Site Setup				
Install & Maintain Best Management Practices	1.0	LS	$ 5,000.00	$ 5,000.00
Circulation Paths & Access Steps				
Excavate & Grade Native Materials	175.0	cy	$ 22.00	$ 3,849.19
Furnish & Install Class 6 Road Base	118.1	Tons	$ 35.00	$ 4,133.50
Furnish & Install Crusher Fine Path	118.1	Tons	$ 35.00	$ 4,133.50
Furnish & Install Landscape Fabric	524.9	SY	$ 6.00	$ 3,149.33
Unclassified Hauloff	175.0	cy	$ 20.00	$ 3,499.26
River Terracing & Beach Area				
Furnish & Install Boulder (Avg 24" B Axis)	218.2	tons	$ 75.00	$ 16,361.92
Furnish & Install Bedding Material	21.0	Tons	$ 30.00	$ 630.00
Furnish & Install Mirafi 180n Filter Fabric	93.3	SY	$ 8.00	$ 746.67
Excavate & Grade Native Materials	159.7	cy	$ 22.00	$ 3,513.89
Furnish & Install Beach Sand	80.2	Tons	$ 35.00	$ 2,806.13
Unclassified Hauloff	159.7	cy	$ 20.00	$ 3,194.44
Drop Structure #1 & Channel Improvements				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	1526.3	Tons	$ 85.00	$ 129,737.68
Excavate & Grade Native Alluvium	604.8	CY	$ 22.00	$ 13,305.93
Furnish & Install Bedding Material	391.8	Tons	$ 30.00	$ 11,754.55
Furnish & Install Mirafi 180n Filter Fabric	1023.6	SY	$ 8.00	$ 8,188.67
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	47.5	CY	$ 272.00	$ 12,921.56
Furnish & Install by Hand Washed Rock Veneer	13.5	Tons	$ 120.00	$ 1,620.11
Unclassified Hauloff	604.8	CY	$ 20.00	$ 12,096.30
Drop Structure #2 & Channel Improvements				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	642.9	Tons	$ 85.00	$ 54,643.93
Excavate & Grade Native Alluvium	225.4	CY	$ 22.00	$ 4,959.17
Furnish & Install Bedding Material	155.1	Tons	$ 30.00	$ 4,651.74
Furnish & Install Mirafi 180n Filter Fabric	387.1	SY	$ 8.00	$ 3,097.18
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	17.6	CY	$ 272.00	$ 4,780.95
Furnish & Install by Hand Washed Rock Veneer	5.7	Tons	$ 120.00	$ 687.75
Unclassified Hauloff	225.4	CY	$ 20.00	$ 4,508.33
Drop Structure #3 & Channel Improvements				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	658.8	Tons	$ 85.00	$ 55,996.87
Excavate & Grade Native Alluvium	227.5	CY	$ 22.00	$ 5,005.20
Furnish & Install Bedding Material	177.4	Tons	$ 30.00	$ 5,322.62
Furnish & Install Mirafi 180n Filter Fabric	432.5	SY	$ 8.00	$ 3,460.20
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	20.3	CY	$ 272.00	$ 5,509.31
Furnish & Install by Hand Washed Rock Veneer	6.7	Tons	$ 120.00	$ 808.50
Unclassified Hauloff	227.5	CY	$ 20.00	$ 4,550.19
Additional Included Items				
Additional Excavator Time as directed by S2o	80	HR	$ 220.00	$ 17,600.00
PROJECT SUBTOTAL				$ 485,224.56
Contingency (15%)				$ 72,783.68
CONSTRUCTION SUBTOTAL				$ 558,008.24
Bathymetric/Topographic Survey				$ 3,401.69
Engineering Design				$ 27,213.50
Hydraulic Modeling				$ 6,803.37
Permitting 404, 401				$ 6,803.37
Permitting Floodplain				$ 6,803.37
Construction Bonding/Ins				$ 16,740.25
Mob and Demob				$ 16,740.25
Construction Stakeout				$ 3,401.69
Construction Monitoring				$ 34,016.87
TOTAL PROJECT COST OPINION				**$ 679,932.6**

The Wasena Park Site

Figure 11: The Wasena Park site looking upstream from the pedestrian bridge

Existing Conditions

Wasena Park is a multi-purpose park located near downtown. The park is one of a series of interconnected parks that are located along the Roanoke River corridor through downtown. The park features adequate access, parking, trails, and bridges to allow users to approach the site from a variety of directions. Wasena also plays host to a number of ball fields and children's play features that draw users from throughout the community.

The park has recently been the location of a major flood mitigation project, discussed below, that was designed to mitigate large flooding events in the reach. The design of structures at this location will likely be held to the strictest standards for no-rise and true feasibility and cost-benefit for this site will likely follow this detailed modeling study during the preliminary design phases.

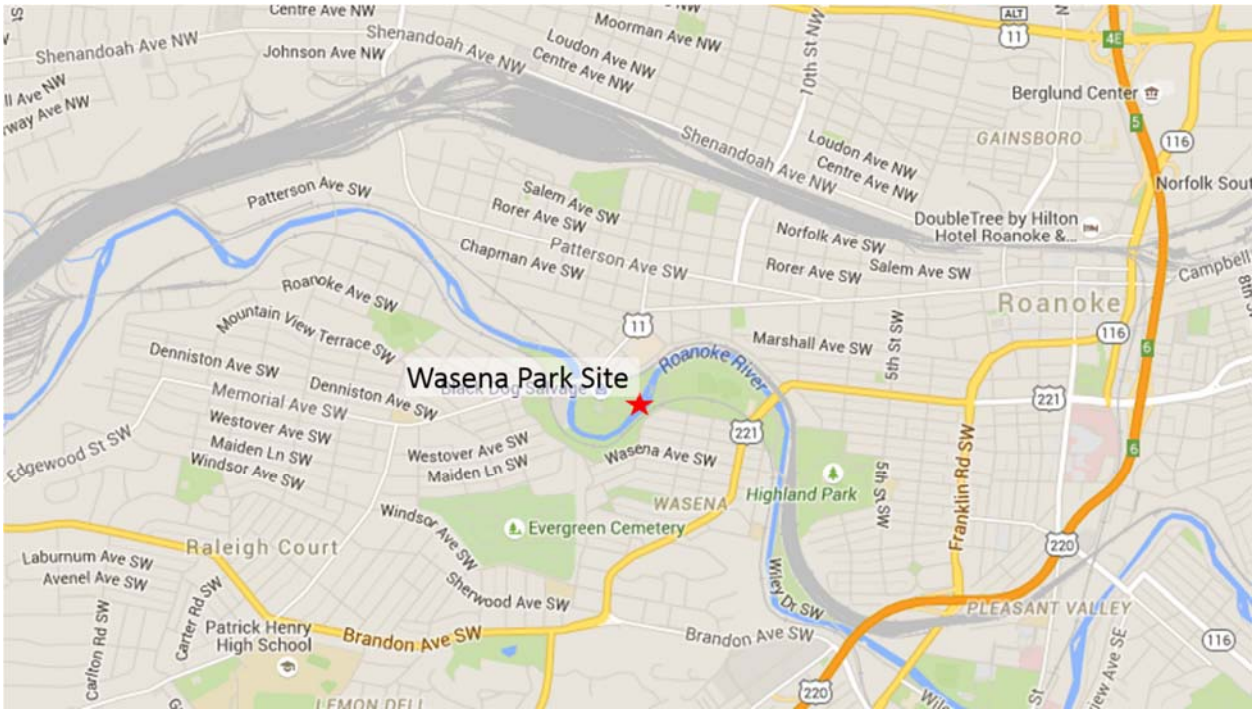

Figure 12: The Wasena Park site is centered on the pedestrian bridge crossing the Roanoke River between Wasena Park and Vic Thomas Park.

Land Ownership

The Wasena Park Project site is located in a public park owned by the City of Roanoke, VA (City of Roanoke Real Estate GIS, 2015). Property ownership for the site is described in Table 55. The most prominent land owner is the Norfolk Southern Railroad, who owns lands on both the North and South Riverbanks immediately upstream and downstream of the city park (Figure 13). Proposed improvements at the site are not expected to impact adjacent lands. Additional private holding are found within the vicinity of the site, though they do not directly abut the lands on which the project is proposed.

A review of historical aerial footage implies that there might be a sewer-line crossing upstream of the riffle that creates the upper-most drop in the site. Prior to preliminary design a surveyor will need to provide detailed survey information as well as ownership and easements within the reach. The lower Wasena project site is entirely on City land with the Wiley Dr. right-of-way on river left and City Owned land on river right.

Figure 13: Aerial Imagery of the upper Wasena project site, showing adjacent land ownership (City of Roanoke Real Estate GIS, 2015). The lower Wasena project site is entirely on City land with the Wiley Dr. right-of-way on river left and City Owned land on river right.

A table of land ownership is shown below:

Table 5: Land ownership adjacent to the Wasena Park project site (City of Roanoke Real Estate GIS, 2015).

TAXID	OWNER	MAILING ADDRESS
1220805	CITY OF ROANOKE STREET	215 CHURCH AVE SW ROANOKE, VA 24016
1221301	CITY OF ROANOKE VIRGINIA	PO BOX 1451 ROANOKE, VA 24007
1221406	CITY OF ROANOKE VIRGINIA	PO BOX 1451 ROANOKE, VA 24007
1221501	CITY OF ROANOKE (WASENA PARK)	PO BOX 1451 ROANOKE, VA 24007
1222301	CITY OF ROANOKE (WASENA PARK)	PO BOX 1451 ROANOKE, VA 24007
1230701	CITY OF ROANOKE	PO BOX 1451 ROANOKE, VA 24007
1230725	CITY OF ROANOKE (WASENA PARK)	PO BOX 1451 ROANOKE, VA 24007
9999999	NORFOLK SOUTHERN RAILROAD ATTN: BILL	1200 PEACHTREE ST NE 7-142 ATLANTA, GA 30309

Flows at the Wasena Park Site

An annual hydrograph describing the median of mean daily flows at the project site is shown in Figure 14. The Figure shows the anticipated seasonal flows for the proposed project site.

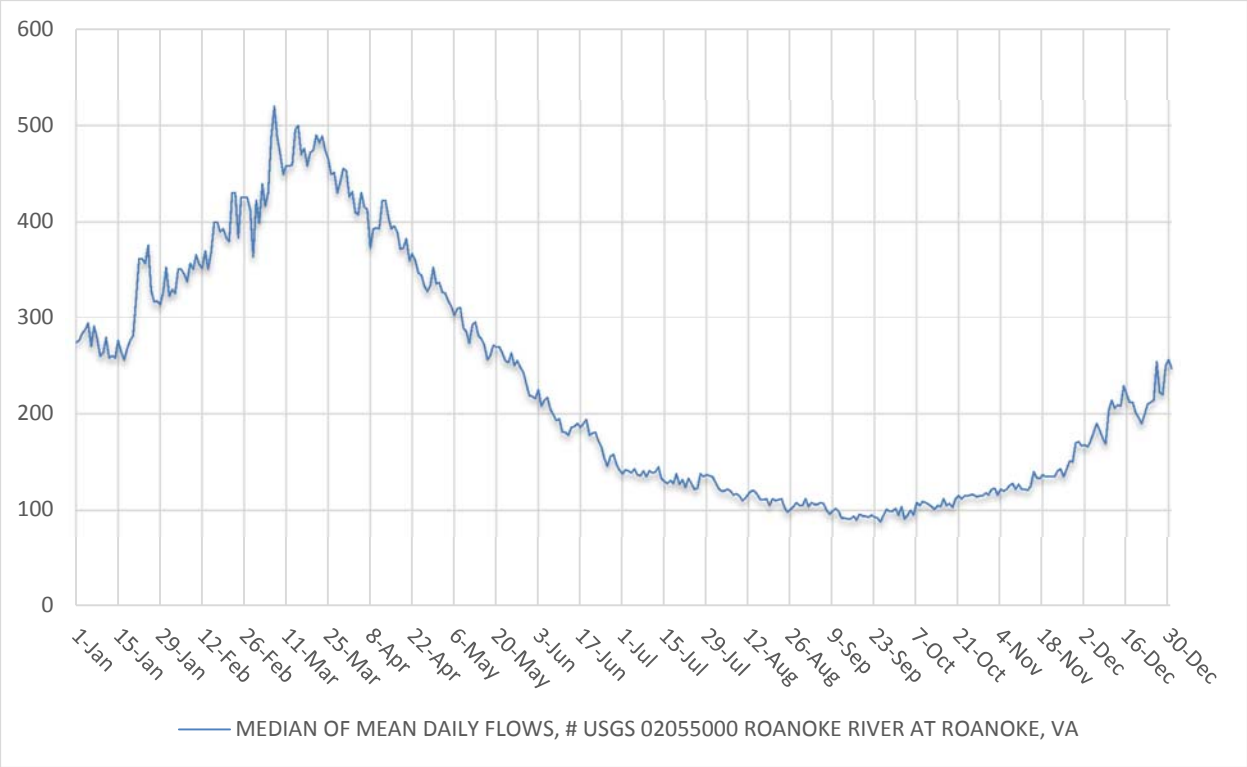

Figure 14: Median of mean daily flows in the Roanoke River downstream of the Wasena Park site.

Peak average flows at this site are in the range of 400-500 cfs. The summer average flows are similar however and remain around the 100 cfs mark. As noted above, these types of flows are great for providing in-stream float and play access but are not sufficient to attract avid kayakers. Avid kayakers tend to pursue flows of around 700-1,000 cfs and higher. The site could be designed to be an attraction during high flow events.

Figure 15, shown below, shows the peak annual flooding events and it can be seen, as expected, that these events are largely in the 15,000-20,000 cfs range with some events that are even higher. At these flow rates the river would be dangerous to navigate and the proposed whitewater park would be inundated. However, at flows of between 1,000 and 3,000 cfs the park would create attractive whitewater that would draw users from throughout the region.

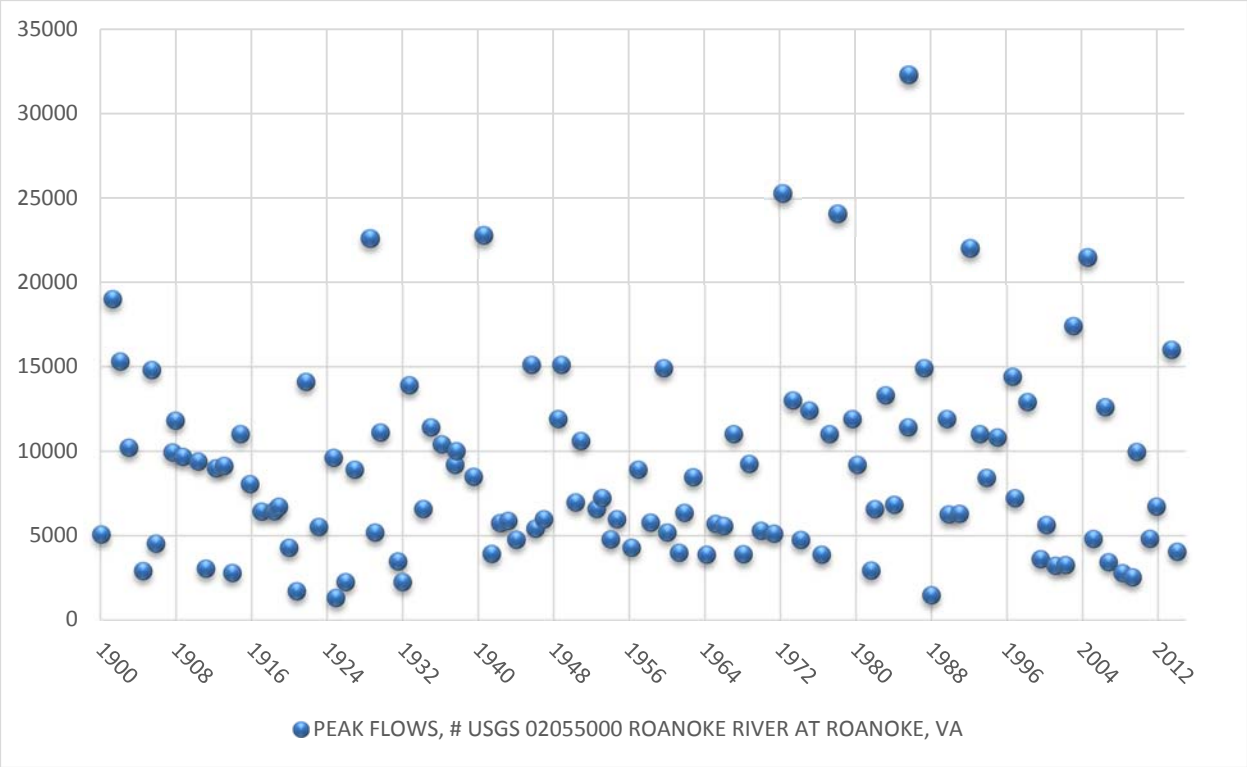

Figure 15: Peak flows measured in the Roanoke River upstream of the Wasena Park site.

Flood Impacts

Wasena Park is the location of an extensive flood mitigation project constructed in partnership with the Federal Government. The project implemented, just downstream of the proposed project site, an extensive flood bench on the inside of the riverbed that creates a connected floodplain to the river and allows high flows to expand and lose energy with a lower resulting impact to surrounding and downstream properties. The flood map for this region can be seen below in Figure 16 and Figure 17.

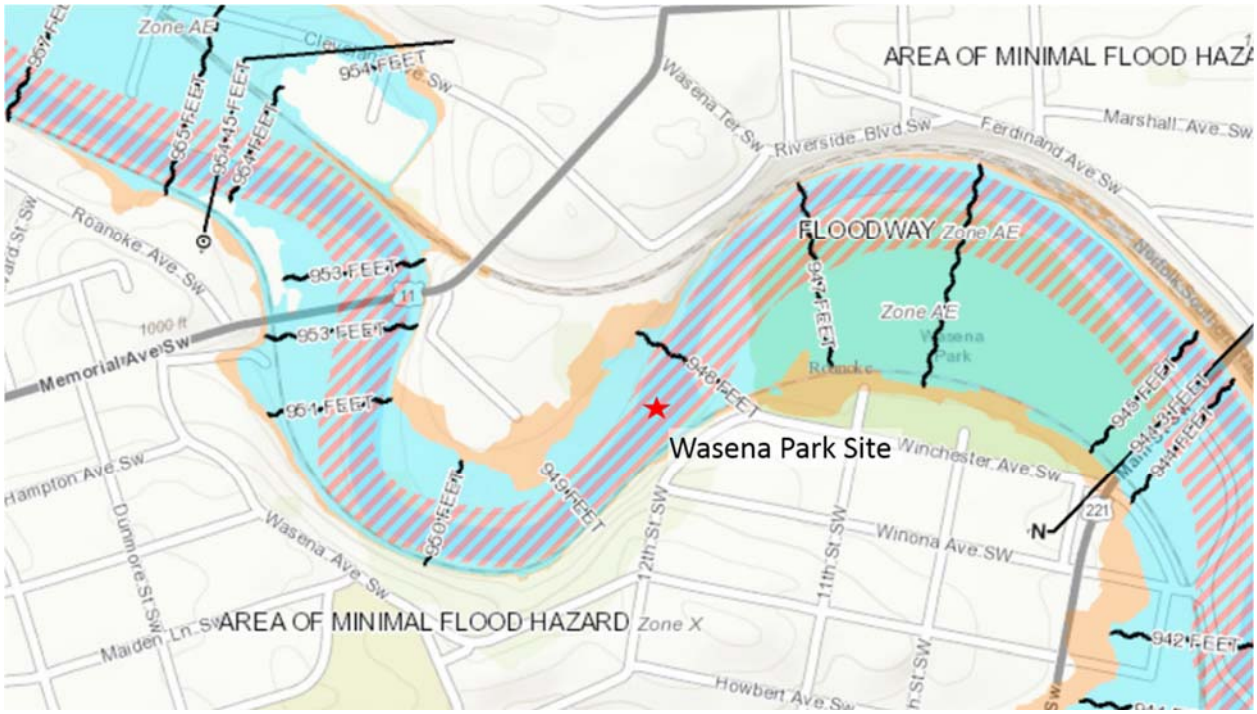

Figure 16: FEMA Flood Hazard Mapping for the Upper Wasena Park project site (FEMA's National Flood Hazard Layer (Official), 2015)

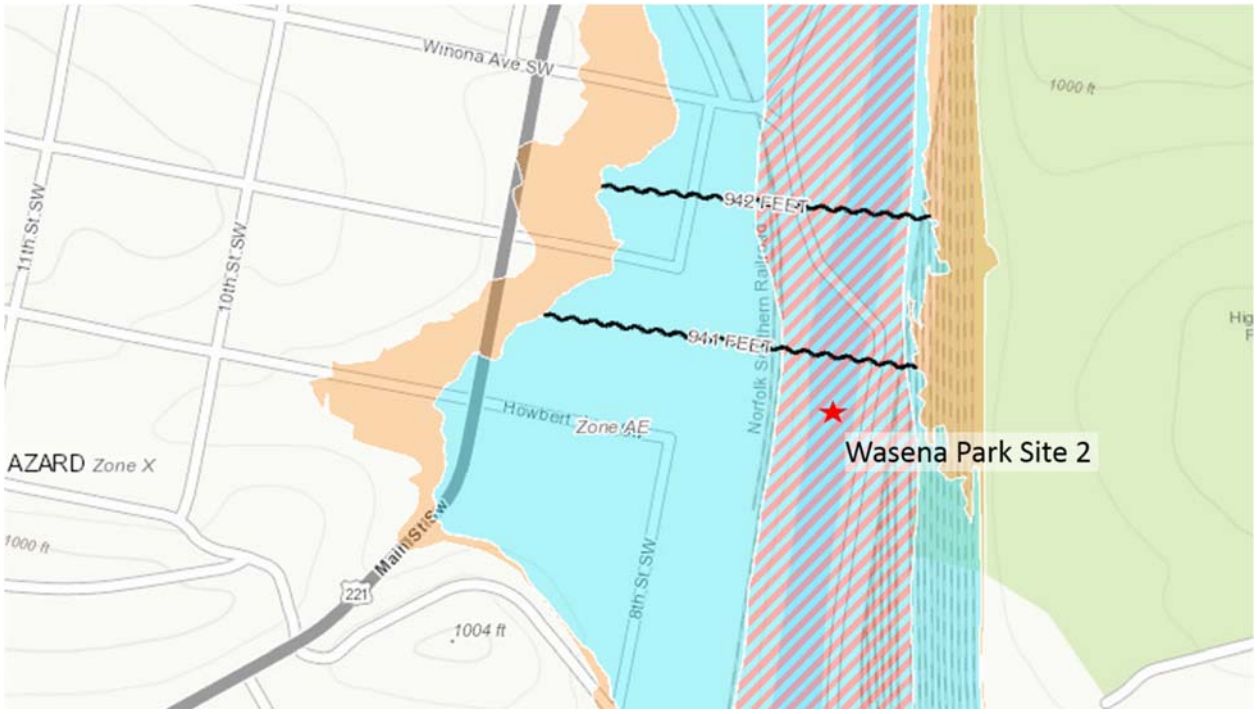

Figure 17. FEMA Flood Hazard Mapping for the Lower Wasena Park project site (FEMA's National Flood Hazard Layer (Official), 2015)

As shown in the Figure above, the proposed project site is located just upstream of the widened flood bench at the location of a pedestrian bridge that crosses the river. At this location the floodplain is slightly narrower although the regulatory floodway is quite wide. Only a single commercial structure, within the 100 year floodplain, was identified within the immediate vicinity Wasena Park site.

Historic Structures

There are two historic structures near the Wasena Park Site, Roanoke Apartments (06000759); and Mountain View (80004221). Neither of the structures is close enough to the project site to be impacted by the proposed project.

Wasena Park Conceptual Design

The Wasena Park Site design is shown below in Figure 188:

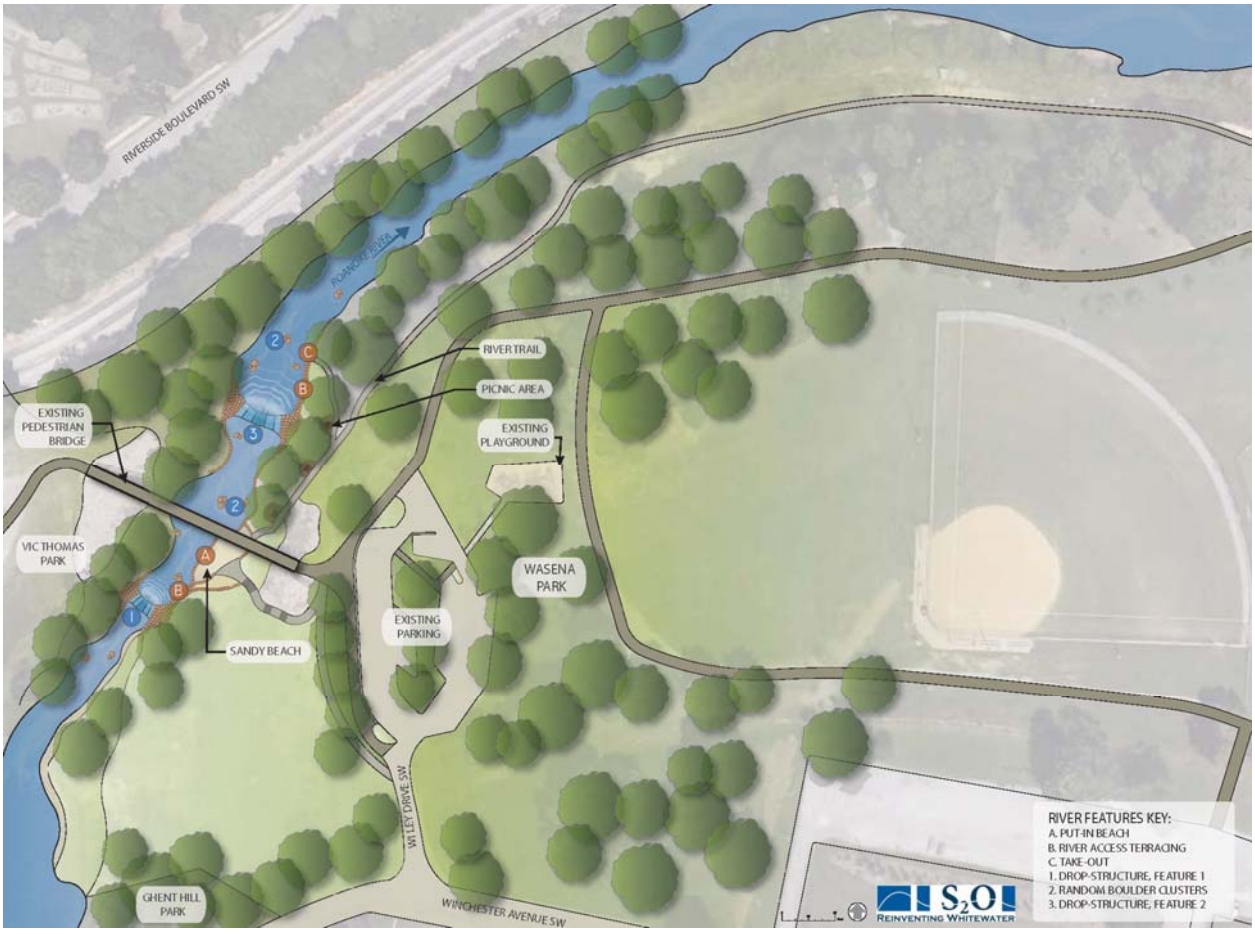

Figure 18: The conceptual design for the Wasena Park Site.

The Lower Wasena Park Site design is shown below in Figure 189:

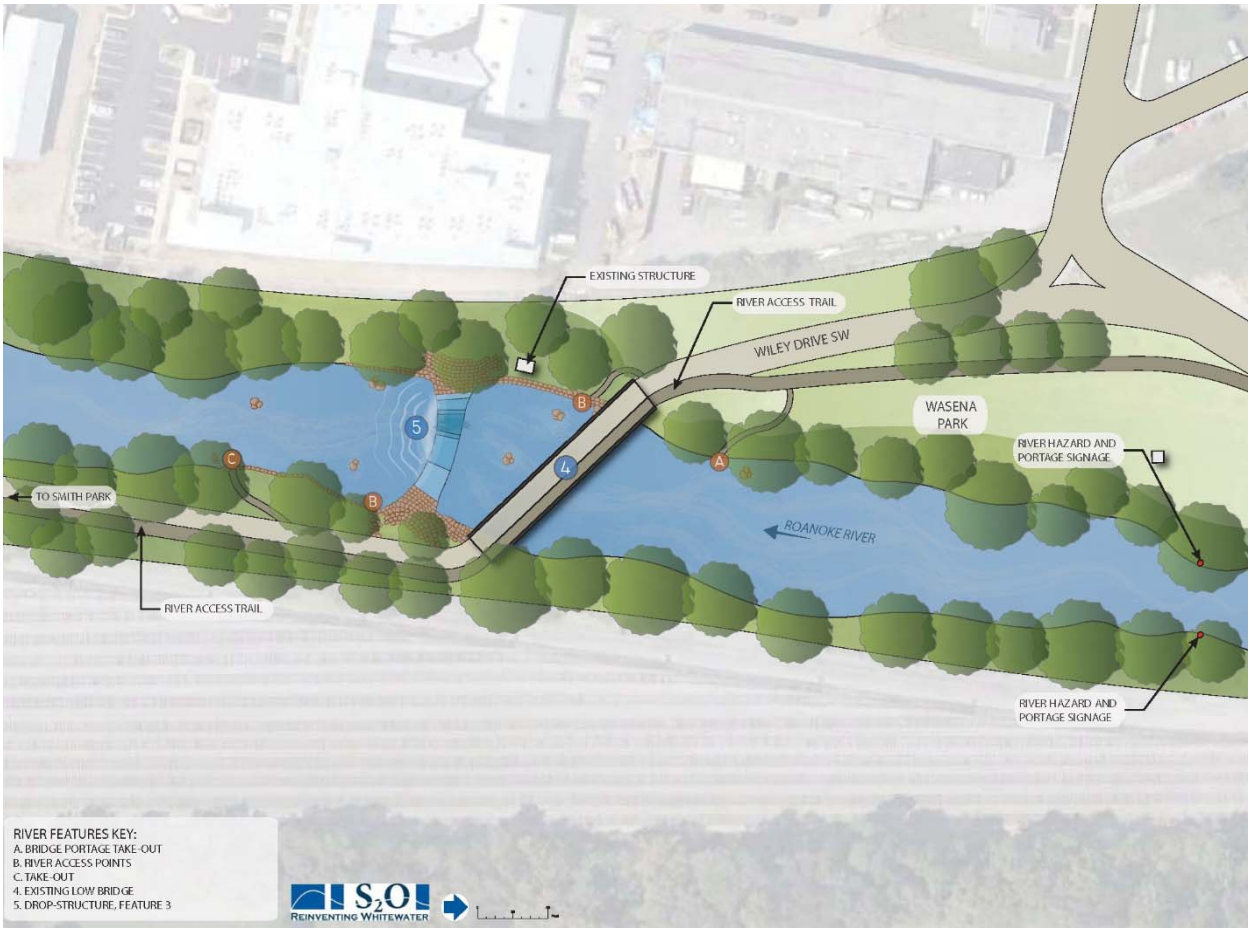

Figure 19: The conceptual design for the Lower Wasena Park Site.

The Wasena Park design is focused around two drop structures near the existing pedestrian bridge at the upstream side of the park. The improvements include improved access from the parking area and two drop structures designed to create freestyle surfing fun at higher flows and to create a drop and a chute at lower flows. The design of this park is focused around "park and play" type boating with most boaters and floaters focusing their play specifically around this whitewater activity area. Boaters and floaters who wish to float downstream further can return to the parking area via existing trails from the downstream end of the park.

The Lower Wasena Park is located near shopping and retail opportunities. This site plan includes an additional drop structure creating freestyle surfing fun at higher flows and a chute at lower flows; a boater portage and river hazard signage above the existing, unnavigable bridge; and multiple river access points along the eastern side of the river.

Wasena Park Opinion of Probably Costs

The Wasena Park conceptual level cost estimate is shown below:

Table 6: Wasena Park conceptual level cost estimate

Project: Roanoke Whitewater Park
Issue Date: 12/01/2015
Developed By: DW

Wasena Park: Estimated Design and Construction Costs

Description	Quantity	Unit	Unit Cost	Item Total Cost
Site Setup				
Install & Maintain Best Management Practices	1.0	LS	$ 5,000.00	$ 5,000.00
Circulation Paths & Access Steps				
Excavate & Grade Native Materials	613.3	cy	$ 22.00	$ 13,491.70
Furnish & Install Class 6 Road Base	414.0	Tons	$ 35.00	$ 14,488.25
Furnish & Install Crusher Fine Path	414.0	Tons	$ 35.00	$ 14,488.25
Furnish & Install Landscape Fabric	1839.8	SY	$ 6.00	$ 11,038.67
Unclassified Hauloff	613.3	cy	$ 20.00	$ 12,265.19
River Terracing & Beach Area				
Furnish & Install Boulder (Avg 36" B Axis)	65.2	tons	$ 85.00	$ 5,543.38
Furnish & Install Bedding Material	7.8	Tons	$ 30.00	$ 232.50
Furnish & Install Mirafi 180n Filter Fabric	34.4	SY	$ 8.00	$ 275.56
Excavate & Grade Native Materials	89.7	cy	$ 22.00	$ 1,974.09
Furnish & Install Beach Sand	71.2	Tons	$ 35.00	$ 2,490.25
Furnish & Install Quarried Limestone Steps	14.7	Tons	$ 300.00	$ 4,400.00
Unclassified Hauloff	89.7	cy	$ 20.00	$ 1,794.63
Drop Structure #1 & Channel Improvements				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	973.2	Tons	$ 85.00	$ 82,719.62
Excavate & Grade Native Alluvium	394.7	CY	$ 22.00	$ 8,683.89
Furnish & Install Bedding Material	267.1	Tons	$ 30.00	$ 8,013.37
Furnish & Install Mirafi 180n Filter Fabric	685.4	SY	$ 8.00	$ 5,483.19
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	32.7	CY	$ 272.00	$ 8,904.01
Furnish & Install by Hand Washed Rock Veneer	8.6	Tons	$ 120.00	$ 1,031.06
Unclassified Hauloff	394.7	CY	$ 20.00	$ 7,894.44
Drop Structure #2 & Channel Improvements				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	1082.1	Tons	$ 85.00	$ 91,974.80
Excavate & Grade Native Alluvium	473.2	CY	$ 22.00	$ 10,410.69
Furnish & Install Bedding Material	261.5	Tons	$ 30.00	$ 7,844.78
Furnish & Install Mirafi 180n Filter Fabric	721.9	SY	$ 8.00	$ 5,775.23
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	27.0	CY	$ 272.00	$ 7,346.98
Furnish & Install by Hand Washed Rock Veneer	7.6	Tons	$ 120.00	$ 909.13
Unclassified Hauloff	473.2	CY	$ 20.00	$ 9,464.26
Drop Structure #3 & Channel Improvements				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	1636.4	Tons	$ 85.00	$ 139,091.17
Excavate & Grade Native Alluvium	664.8	CY	$ 22.00	$ 14,624.70
Furnish & Install Bedding Material	369.0	Tons	$ 30.00	$ 11,069.50
Furnish & Install Mirafi 180n Filter Fabric	1061.8	SY	$ 8.00	$ 8,494.13
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	32.8	CY	$ 272.00	$ 8,929.03
Furnish & Install by Hand Washed Rock Veneer	10.5	Tons	$ 120.00	$ 1,257.00
Unclassified Hauloff	664.8	CY	$ 20.00	$ 13,295.19
Additional Included Items				
Additional Excavator Time as directed by S2o	80	HR	$ 220.00	$ 17,600.00
PROJECT SUBTOTAL				$ 627,298.63
Contingency (15%)				$ 94,094.79
CONSTRUCTION SUBTOTAL				$ 721,393.43
Bathymetric/Topographic Survey				$ 3,401.69
Engineering Design				$ 27,213.50
Hydraulic Modeling				$ 6,803.37
Permitting 404, 401				$ 6,803.37
Permitting Floodplain				$ 6,803.37
Construction Bonding/Ins				$ 21,641.80
Mob and Demob				$ 21,641.80
Construction Stakeout				$ 3,401.69
Construction Monitoring				$ 34,016.87
TOTAL PROJECT COST OPINION				**$ 853,120.9**

The Explore Park Site

Figure 20: The Adventure Park Site is located at an existing riffle and drop section of the Roanoke River.

Existing Conditions

The Adventure Park Site is located adjacent to an adventure destination that features a visitor's center and a number of proposed attractions. The whitewater site is located via a private and gated dirt road but access would be improved and parking provided if whitewater improvements were made. An unimproved dirt road parallels the river and would allow, with some improvement, pedestrian access up and down the river for construction as well as for users wishing to float a longer section of the river.

The river is largely composed of bedrock which, at lower levels, impedes the ability to easily float the river. There is one large bedrock ledge central to the proposed site which drops approximately 1' and could be improved to focus the flows of the river as well as to create a larger drop at lower flows.

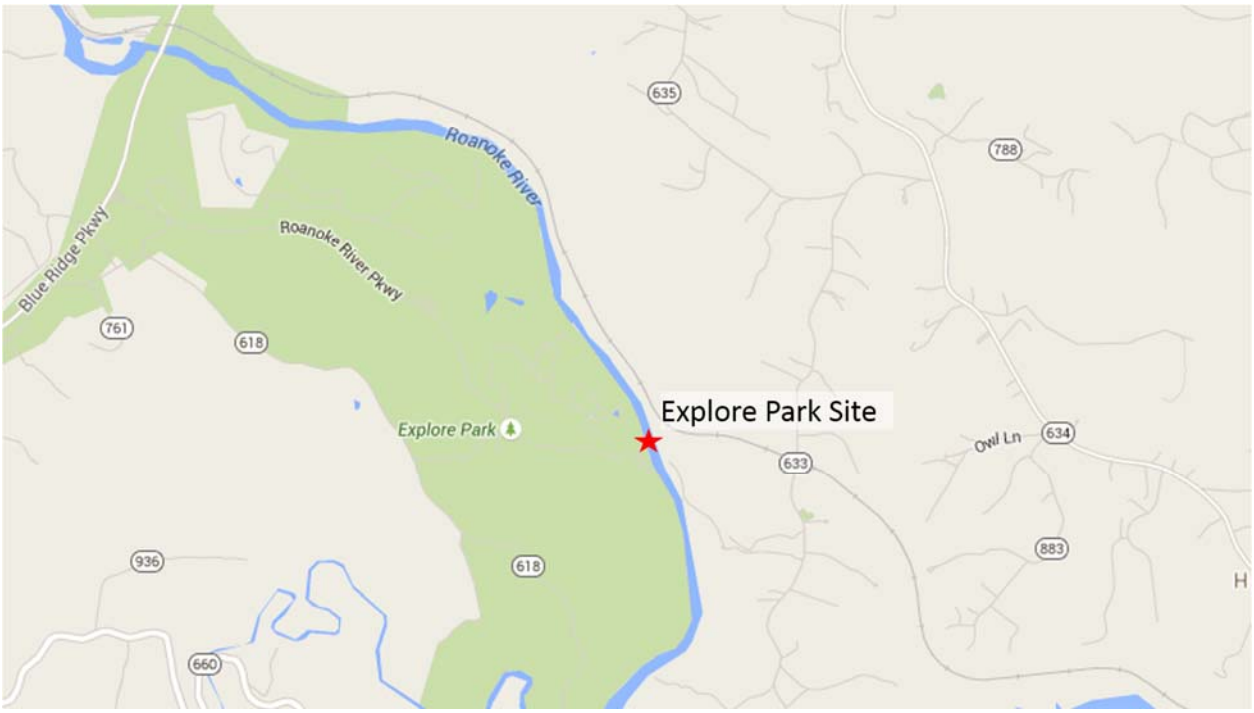

Figure 21: The Explore Park site is located downhill from the Explore Park Visitors Center on the banks of the Roanoke River.

Land Ownership

Explore park shares ownership between two owners with Roanoke County to the west and James and Jill Bass to the east (Roanoke County, VA Tax Parcel Viewer, 2015). Jurisdiction of the project site also appears to be split along the centerline of the river channel between Roanoke County to the west and Bedford County to the east. Nearby land owners to the site also include the Norfolk Southern Railroad, who owns lands immediately upstream of the project site (Table 77). Again, impacts from the project are not expected in this area. See Figure 222, below for ownership boundaries:

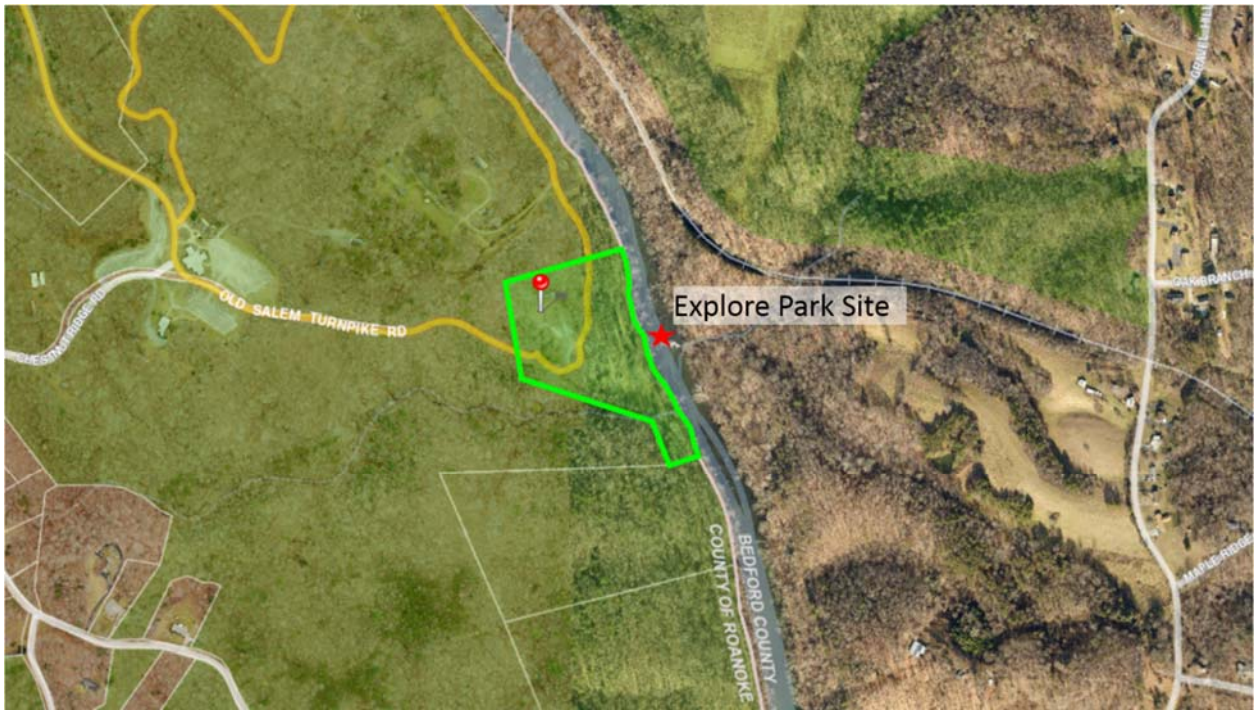

Figure 22: Aerial Imagery of the Explore Park project site, showing adjacent land ownership (Roanoke County, VA Tax Parcel Viewer, 2015).

A Table of land ownership is shown below:

Table 7: Land ownership adjacent to the Explore Park project site (Roanoke County, VA Tax Parcel Viewer, 2015).

PARCEL ID	OWNER	MAILING ADDRESS
080.00-05-26.00-0000	VIRGINIA RECREATIONAL FAC AUTH	1206 Kessler Mill Road Salem, VA 24153
080.00-05-24.00-0000	VIRGINIA RECREATIONAL FAC AUTH	1206 Kessler Mill Road Salem, VA 24153
080.00-05-17.00-0000	VIRGINIA RECREATIONAL FAC AUTH	1206 Kessler Mill Road Salem, VA 24153
NA	NORFOLK SOUTHERN RAILROAD	1200 PEACHTREE ST ATLANTA, GA 30309
17205600	BASS JAMES LOUIS III & JILL FISHER	2419 GRAVEL HILL RD VINTON , VA 24179

Flows at the Explore Park Site

An annual hydrograph describing the median of mean daily flows at the project site is shown in Figure 233. The Figure shows the anticipated seasonal flows for the proposed project site.

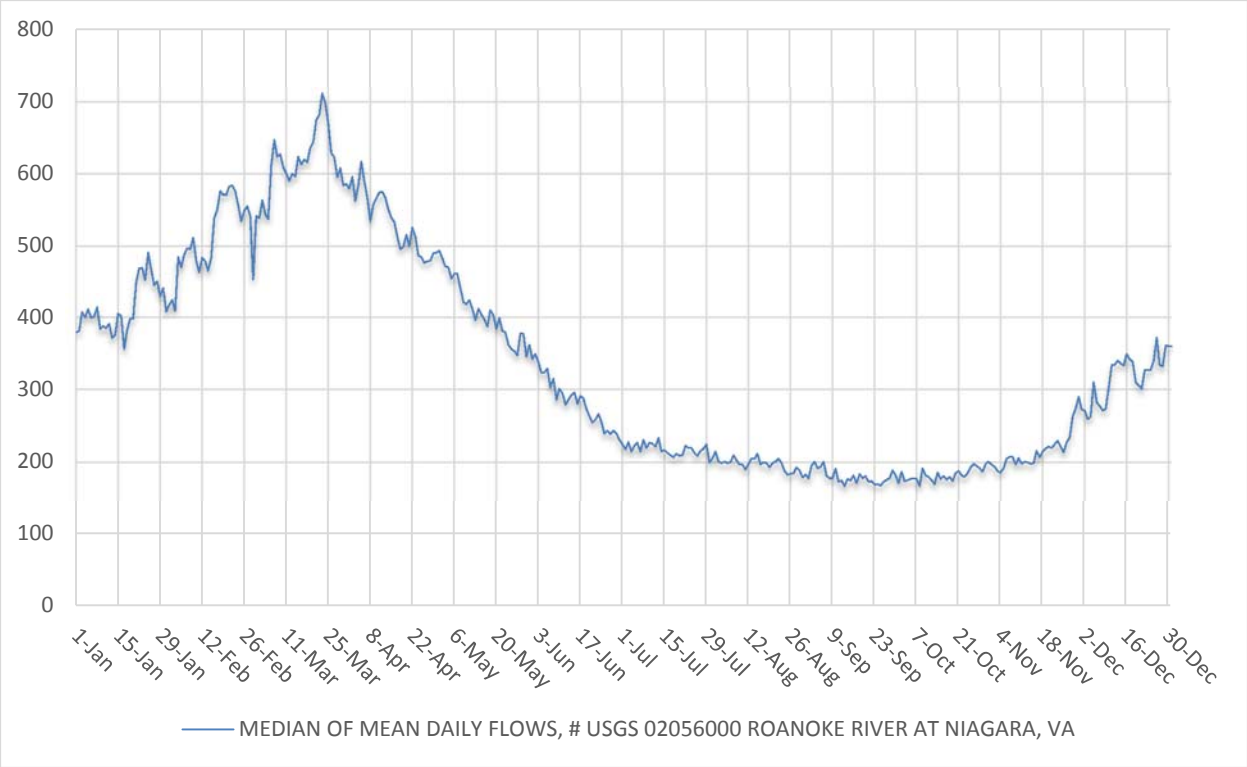

Figure 23: Median of mean daily flows in the Roanoke River upstream of the Explore Park site.

The average peak flows at this site are between 500-700 cfs with average summer flows being in the 200 cfs range. At average peak flows the whitewater features will be an attraction to beginner and intermediate boaters to try surfing and basic whitewater maneuvers. At higher flows the waves will grow in power and complexity and will become an attraction to more and more users.

At lower summer flows the features and anticipated changes will augment the existing uses at the Explore Park. The improved river conditions and trail upgrades will create an opportunity to attract tubers and inflatable kayakers who will enjoy the adventure of pursing whitewater sport at a controlled flow rate.

Figure 244 shows peak flooding that is often in the 15,000 to 20,000 cfs range with some floods exceeding 50,000. The design of the park will need to include features that are robust and anchored to the bedrock in order to sustain forceful flooding on a yearly basis.

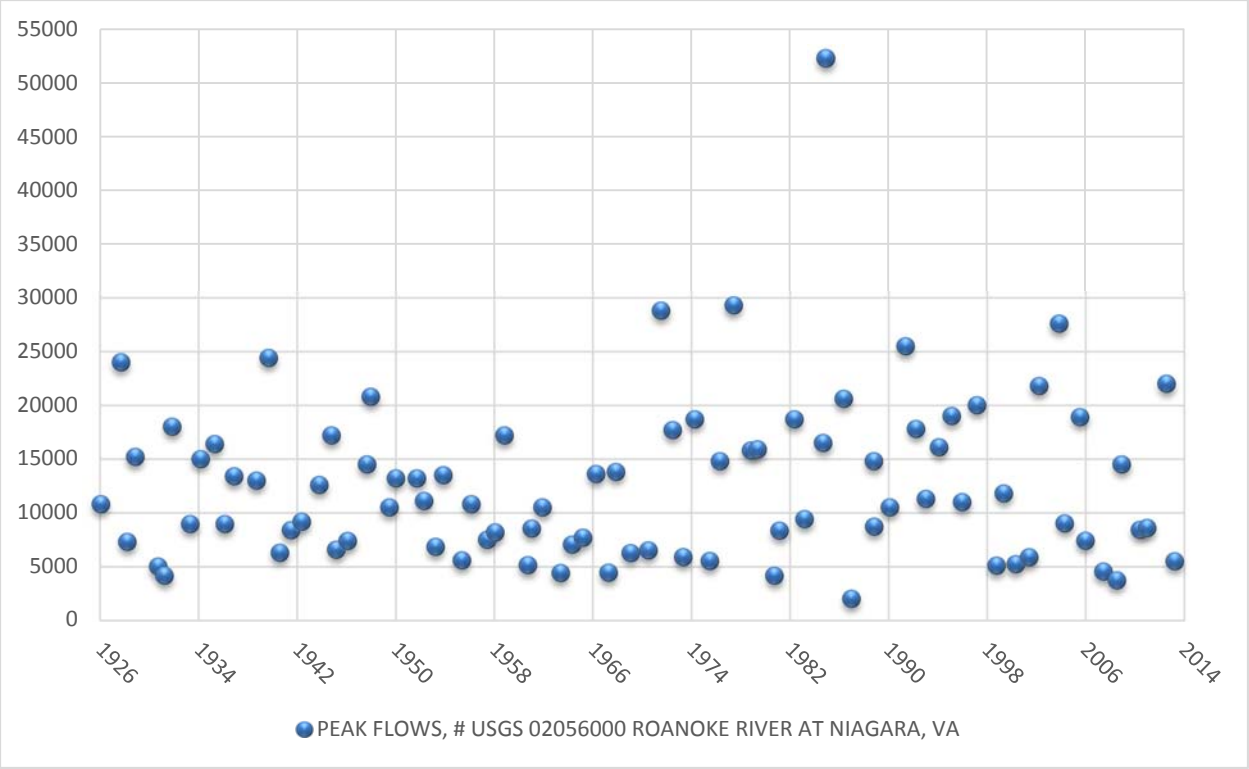

Figure 24: Peak flows measured in the Roanoke River upstream of the Explore Park site.

Flood Risk

Figure 25: FEMA Flood Hazard Mapping for the Explore Park project site (FEMA's National Flood Hazard Layer (Official), 2015).

Flooding at the Explore Park site appears to be entirely contained within primary river channel, and does not appear to affect neighboring structures on adjoining properties.

The Explore Park Conceptual Design:

The proposed conceptual design for the Adventure Park Site is shown below in Figure 266:

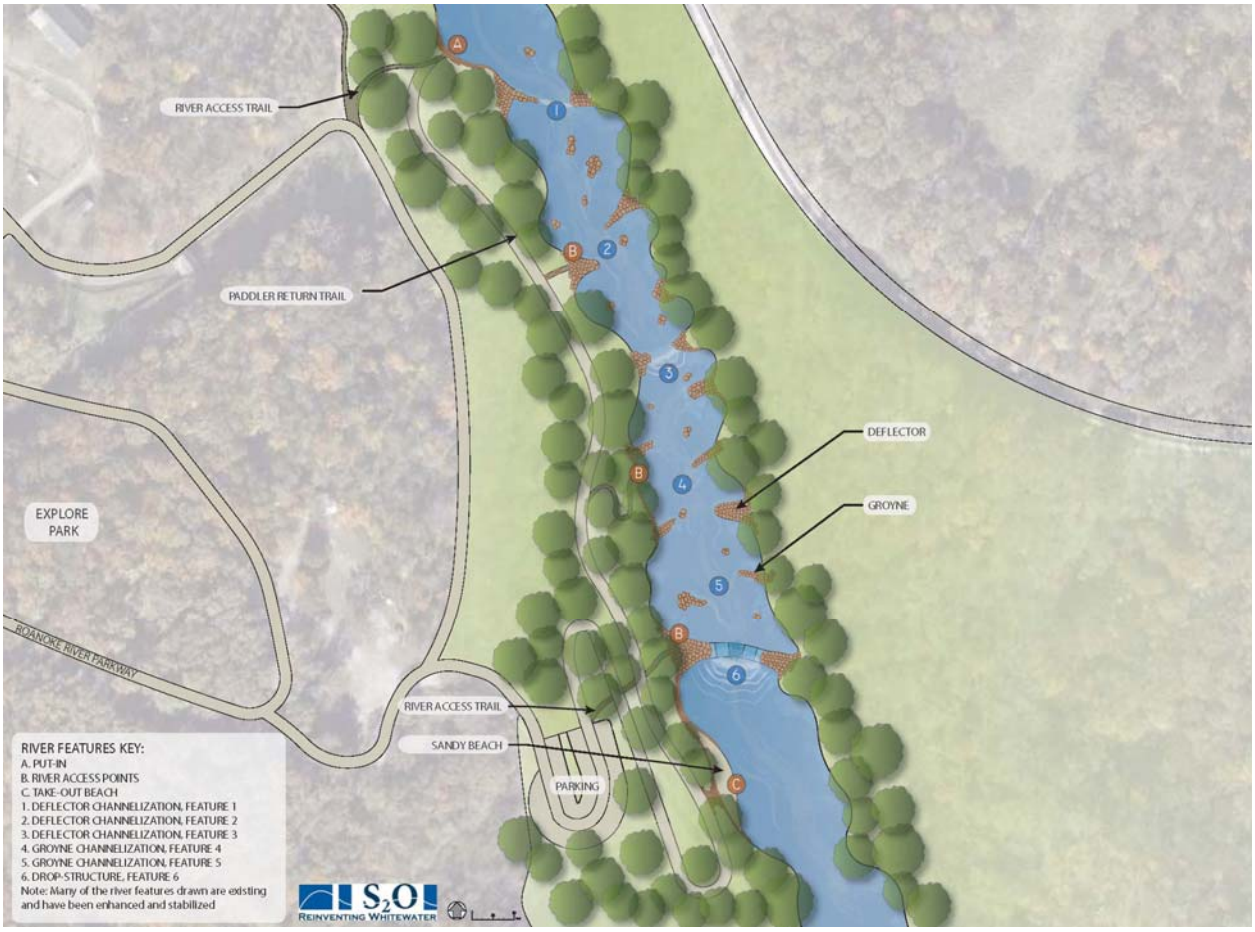

Figure 26: The Conceptual Design for the Adventure Park Site.

The Explore Park Site design includes renovation of the existing trail access and navigability improvements throughout the float reach. The navigability improvements are point bars that are created by augmenting existing bedrock outcroppings. These point bars will serve to create a deeper and more navigable central channel that can be used for tubing and floating at lower levels. The central channel will then flow over a signature drop at the downstream end of the reach. At higher flows this drop will create a surfing wave for kayakers and stand-up paddle boarders. The intent of the design is to create summer attraction that visitors to the Adventure Park can use to tube over-and-over again by recirculating up the walking path. During rain events these improvements will create a more powerful rapid with eddies and chutes and the signature drop at the downstream end. Improvements also include a beach area and recommended parking improvements near the boating area. The design also includes an optional drop structure upgrade by placing pneumatic headgates in feature 6. The headgates would allow the drop to be easily adjusted for varying flow rates and for a variety of users, maximizing the site's recreational potential.

Explore Park Opinion of Probably Costs:

The conceptual level cost estimate for the Explore Park project is shown below:

Table 8: Adventure Park Cost Estimate

Project: Roanoke Whitewater Park
Issue Date: 12/01/2015
Developed By: DW

Explore Park: Estimated Design and Construction Costs

Description	Quantity	Unit	Unit Cost	Item Total Cost
Site Setup				
Install & Maintain Best Management Practices	1.0	LS	$ 5,000.00	$ 5,000.00
Circulation Paths & Access Steps				
Excavate & Grade Native Materials	59.3	cy	$ 22.00	$ 1,305.33
Furnish & Install Class 6 Road Base	40.1	Tons	$ 35.00	$ 1,401.75
Furnish & Install Crusher Fine Path	40.1	Tons	$ 35.00	$ 1,401.75
Furnish & Install Landscape Fabric	178.0	SY	$ 6.00	$ 1,068.00
Furnish & Install Quarried Limestone Steps	51.3	Tons	$ 300.00	$ 15,400.00
Unclassified Hauloff	59.3	cy	$ 20.00	$ 1,186.67
River Terracing & Beach Area				
Furnish & Install Boulder (Avg 24" B Axis)	236.6	tons	$ 75.00	$ 17,742.50
Furnish & Install Bedding Material	23.2	Tons	$ 30.00	$ 695.63
Furnish & Install Mirafi 180n Filter Fabric	103.1	SY	$ 8.00	$ 824.44
Excavate & Grade Native Materials	206.7	cy	$ 22.00	$ 4,546.41
Furnish & Install Beach Sand	129.4	Tons	$ 35.00	$ 4,529.88
Unclassified Hauloff	206.7	cy	$ 20.00	$ 4,133.10
Drop Structure #1				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	797.6	Tons	$ 85.00	$ 67,795.80
Excavate & Grade Native Alluvium	192.6	CY	$ 22.00	$ 4,237.04
Furnish & Install Bedding Material	265.4	Tons	$ 30.00	$ 7,961.76
Furnish & Install Mirafi 180n Filter Fabric	614.3	SY	$ 8.00	$ 4,914.67
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	37.5	CY	$ 272.00	$ 10,194.71
Furnish & Install by Hand Washed Rock Veneer	11.3	Tons	$ 120.00	$ 1,355.78
Unclassified Hauloff	192.6	CY	$ 20.00	$ 3,851.85
Pneumatic Adjustable Gates				
Furnish & Install Obermeyer Pneumatic Gates	65	FT	$ 4,000.00	$ 260,000.00
Boulder Weir Structures				
Operate & Maintain Water Control	1.0	LS	$ 15,000.00	$ 15,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	1095.9	Tons	$ 85.00	$ 93,149.67
Excavate & Grade Native Alluvium	246.0	CY	$ 22.00	$ 5,411.75
Unclassified Hauloff	246.0	CY	$ 20.00	$ 4,919.77
Additional Included Items				
Additional Excavator Time as directed by S2o	80	HR	$ 220.00	$ 17,600.00
PROJECT SUBTOTAL				$ 586,628.25
Contingency (15%)				$ 87,994.24
CONSTRUCTION SUBTOTAL				$ 674,622.49
Bathymetric/Topographic Survey				$ 3,401.69
Engineering Design				$ 27,213.50
Hydraulic Modeling				$ 6,803.37
Permitting 404, 401				$ 6,803.37
Permitting Floodplain				$ 6,803.37
Construction Bonding/Ins				$ 20,238.67
Mob and Demob				$ 20,238.67
Construction Stakeout				$ 3,401.69
Construction Monitoring				$ 34,016.87
TOTAL PROJECT COST OPINION				$ 803,543.7

The Tinker Creek Site

Figure 27 The Tinker Creek Site is located below an old diversion dam.

Existing Conditions

The Tinker Creek project site is located below an old diversion dam which pushed water into a mill race for industrial uses. Remnants of the old mill race are still in existence on the site. The project site consists of the dam, which drops approximately 10' and then a steep reach of Tinker Creek which flows into a pool approximately 1000' downstream of the dam. The riverbed is rocky with large amounts of riparian growth on several islands within the reach.

The site has existing road access and parking as well as an improved grassy area near the creek. The mill race and dam are in need of some repair and maintenance in order to be functional. A detailed location map of the site is shown below:

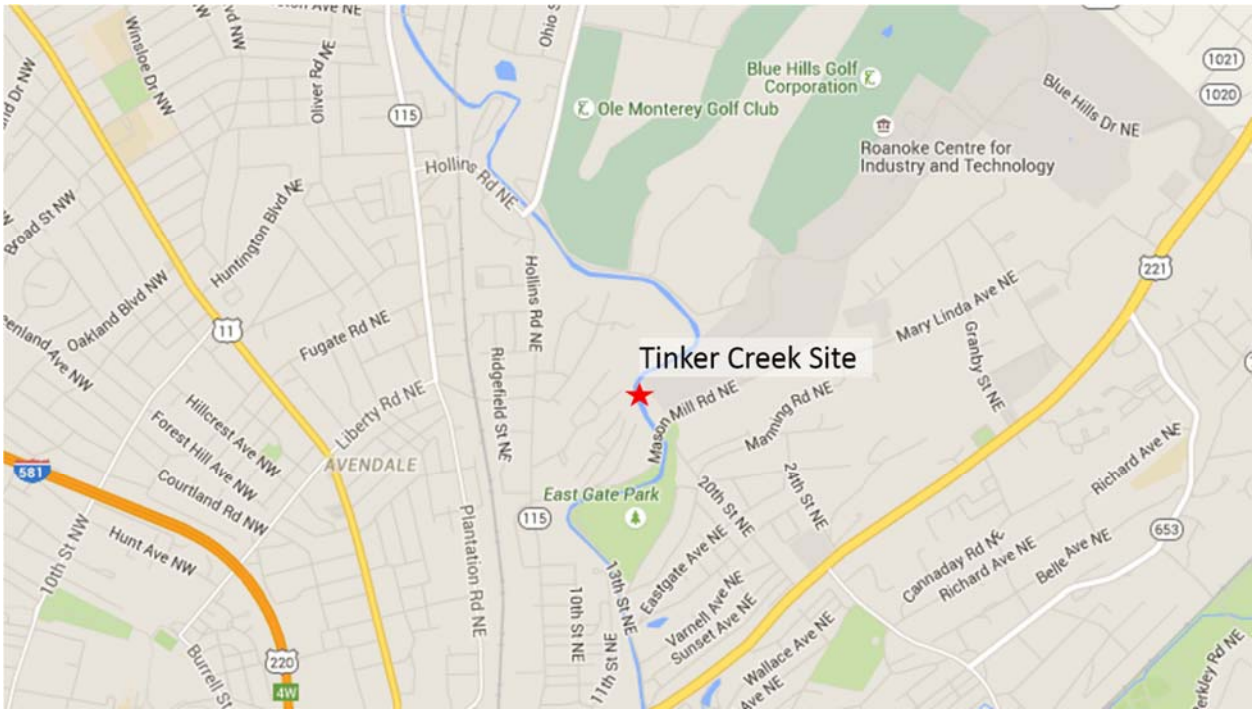

Figure 28: The Tinker Creek site is located just upstream of the Mason Mill Rd crossing of Tinker Creek, at an existing concrete diversion structure.

Land Ownership

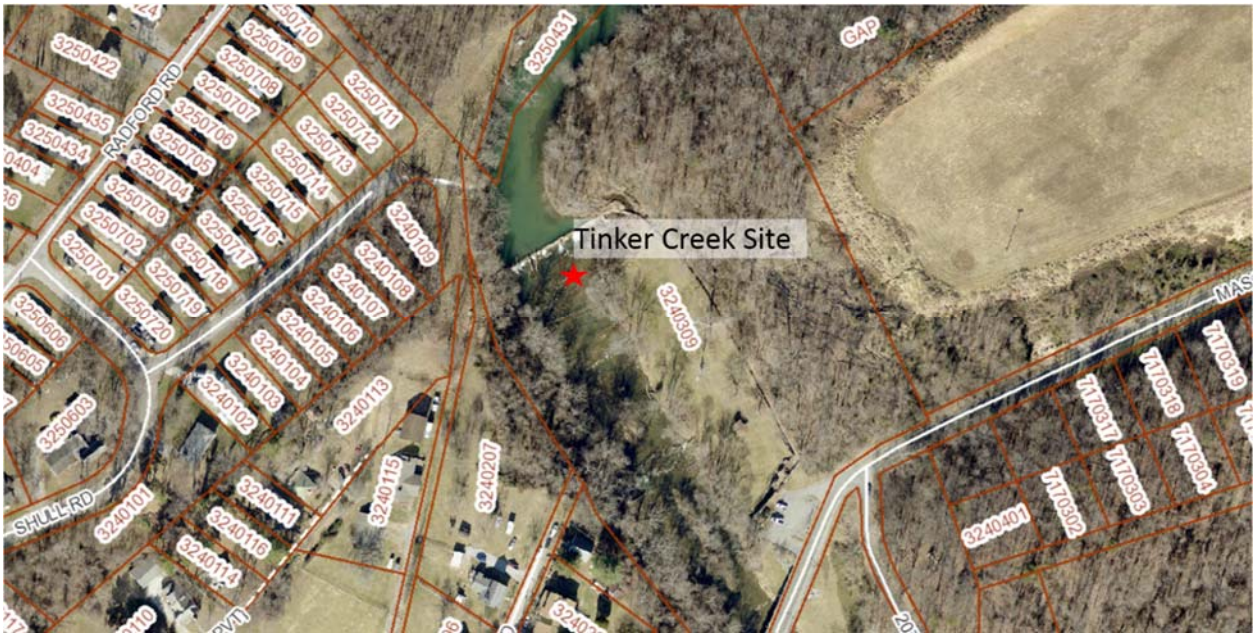

Figure 29: Aerial Imagery of the Tinker Creek project site, showing adjacent land ownership (City of Roanoke Real Estate GIS, 2015).

The Tinker Creek site is located on municipal property owned by the City of Roanoke, VA (City of Roanoke Real Estate GIS, 2015). There are two land owners with properties immediately adjacent to the proposed project site including Eldridge and Laura Crawford and Edward Kirk, both of whom own parcels on the

southwest riverbank immediately adjacent to the proposed site improvements (Figure *299*). Additional land owners with properties adjacent to the parcel on which the proposed project is located are described in Table 99. Numerous other public and private holdings, which do not directly abut to lands on which the project is proposed, are also found in the vicinity of the project site.

A Table of land ownership is shown below:

Table 9: Land ownership adjacent to the Tinker Creek project site (City of Roanoke Real Estate GIS, 2015).

TAXID	OWNER	MAILING ADDRESS
7220102	WILSON EDWIN & JUNE M TRUSTEE	401 TINKER CREEK LANE ROANOKE, VA 24019
3240207	CRAWFORD ELDRIDGE L & LAURA S	2416 OVERLOOK RD NE ROANOKE, VA 24012
3240217	KIRK EDWARD JACKSON	39 CROSSCREEK CIR CLOVERDALE, VA 24077
3240306	CITY OF ROANOKE	PO BOX 1451 ROANOKE, VA 24007
3240309	CITY OF ROANOKE	PO BOX 1451 ROANOKE, VA 24007
3250414	CALLAHAN ROBERT M & CAROLYN H	150 BOON BERNARD DR BOONES MILL, VA 24065
3250431	WESTERN VIRGINIA WATER AUTHORITY	601 S JEFFERSON ST SW STE 200 ROANOKE, VA 24011

Flows at the Tinker Creek Site

An annual hydrograph describing the median of mean daily flows at the project site is shown in Figure 3030. The Figure shows the anticipated seasonal flows for the proposed project site.

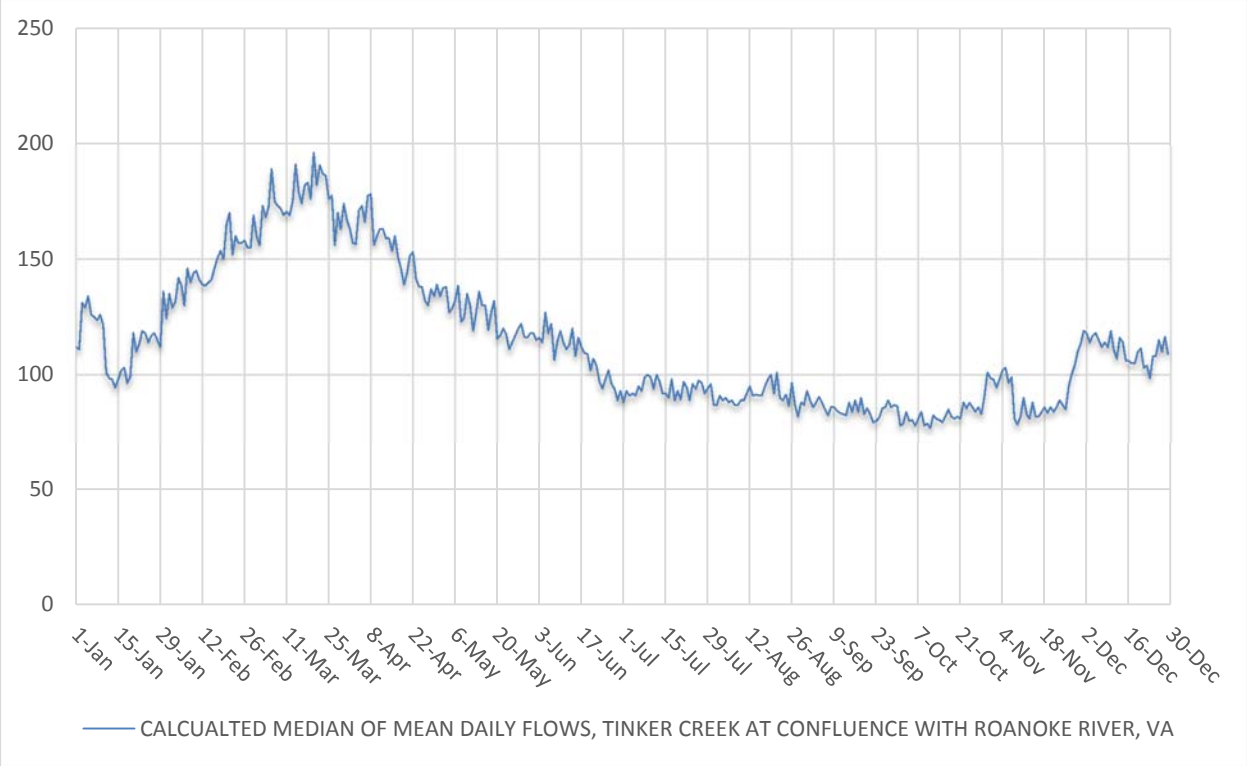

Figure 30: Calculated median of mean daily flows in Tinker Creek downstream of the Tinker Creek site near the confluence with the Roanoke River.

Flows in Tinker Creek are lower than seen at all of the three other sites. These flows are in the range of 150 cfs during peak average times with summer flows averaging around 100 cfs. These flows are sufficient for a float park but would likely not create a significant kayaking attraction.

Calculated peak flows on Tinker Creek are shown below in Figure 31. These flows suggest that yearly peak floods regularly occur in the 5-6000 cfs range with some floods flowing even higher.

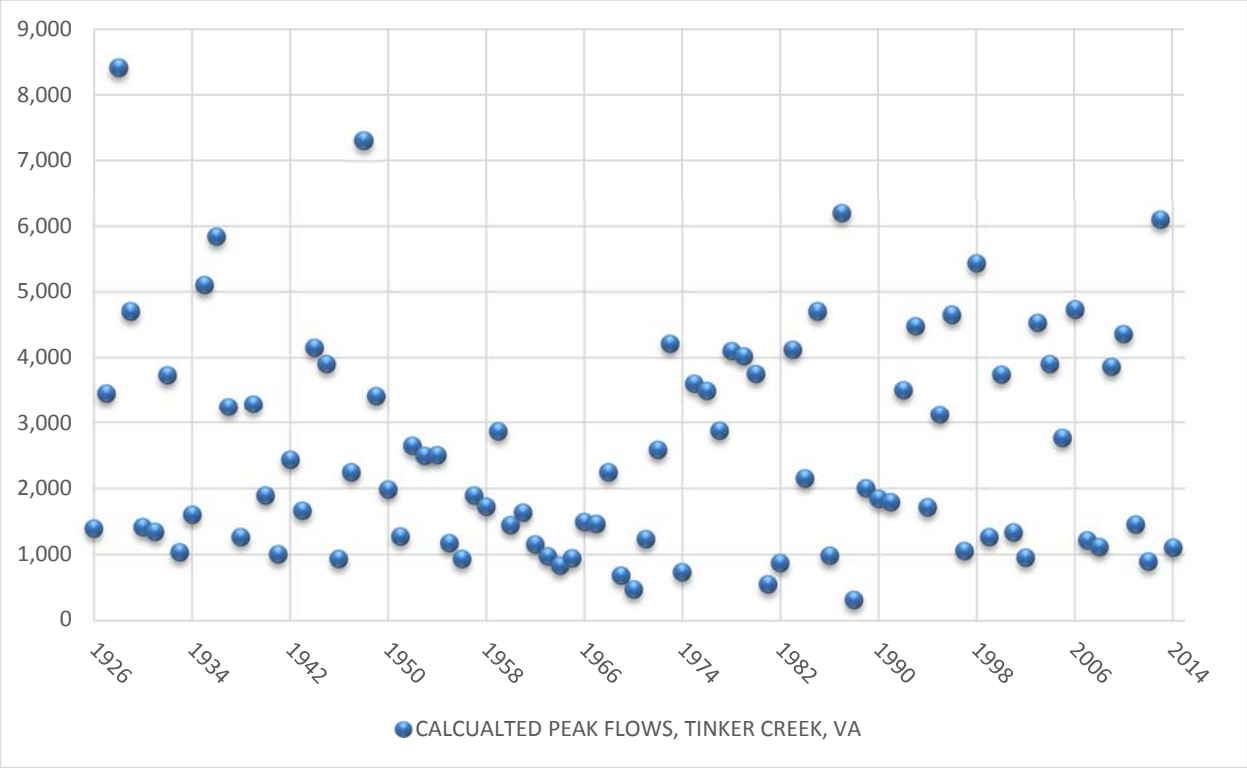

Figure 31: Peak flows calculated for Tinker Creek downstream of the proposed project site.

Flood Impacts:

The flood map for Tinker Creek is shown below in Figure 3232:

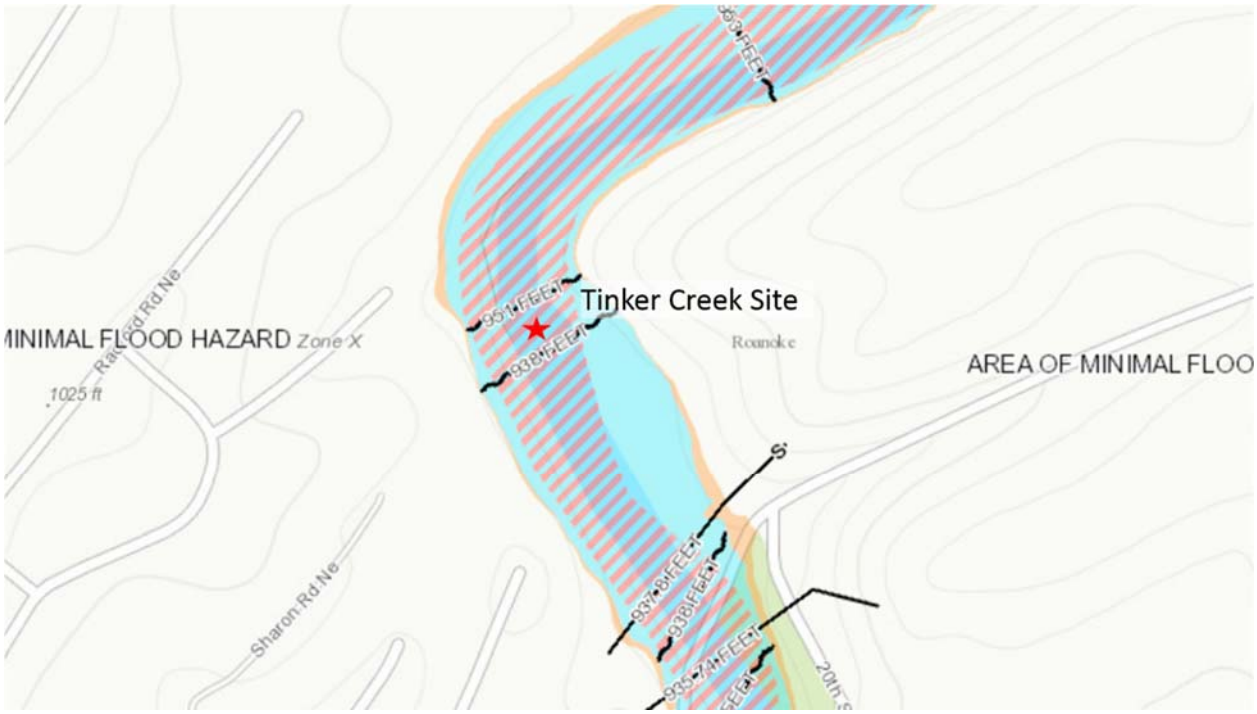

Figure 32: FEMA Flood Hazard Mapping for the Tinker Creek project site (FEMA's National Flood Hazard Layer (Official), 2015).

Flooding at the Tinker Creek site appears to be entirely contained within primary river channel, and does not appear to affect neighboring structures on adjoining properties.

The Tinker Creek Site Conceptual Design:

The conceptual design for the Tinker Creek Site is shown below in Figure 3333:

Figure 33: The conceptual design for the Tinker Creek Site.

The Tinker Creek Conceptual Design is intended to create a number of differing attractions. The in-stream improvements are designed to augment the existing rapid in front of the parking and park area. This includes the construction of drop structures for creating rapid chutes and the channelization of lower flows into a main chute. Several eddies will be created using point bars and the islands will be armored with some overgrowing trees and shrubs removed to allow for safe boater passage.

Additionally, dry land improvements including a bouldering area, some park improvements, and a kids-play stream will also be added. The kids play stream will utilize the existing mill race to create a flowing gravel kids stream where rocks and dams can be created and kids can float tiny boats and other water toys down the channel. Flows will be splash depth and will be controlled at the headgates of the channel.

Figure 34: A kid's play stream created in the Denver Area.

Tinker Creek Opinion of Probably Costs:

S2o has created a cost estimate for this design shown below in Table 1010:

Table 10: Tinker Creek Cost Estimate

Project: Roanoke Whitewater Park
Issue Date: 9/10/2015
Developed By: DW

Tinker Creek: Estimated Design and Construction Costs

Description	Quantity	Unit	Unit Cost	Item Total Cost
Site Setup				
Traffic Control	1.0	LS	$ 5,000.00	$ 5,000.00
Install & Maintain Best Management Practices	1.0	LS	$ 5,000.00	$ 5,000.00
Circulation Paths & Access Ramps				
Excavate & Grade Native Materials	261.1	cy	$ 22.00	$ 5,745.26
Furnish & Install Class 6 Road Base	176.3	Tons	$ 35.00	$ 6,169.63
Furnish & Install Crusher Fine Path	176.3	Tons	$ 35.00	$ 6,169.63
Furnish & Install Landscape Fabric	783.4	SY	$ 6.00	$ 4,700.67
Unclassified Hauloff	261.1	cy	$ 20.00	$ 5,222.96
River Access & Beach Area				
Furnish & Install Boulder (Avg 36" B Axis)	288.6	tons	$ 85.00	$ 24,527.97
Furnish & Install Bedding Material	29.0	Tons	$ 30.00	$ 870.00
Furnish & Install Mirafi 180n Filter Fabric	128.9	SY	$ 8.00	$ 1,031.11
Excavate & Grade Native Materials	243.3	cy	$ 22.00	$ 5,352.72
Furnish & Install Beach Sand	88.5	Tons	$ 35.00	$ 3,097.50
Furnish & Install Cellular Containment Grid	115.2	sy	$ 75.00	$ 8,641.67
Furnish & Install Topsoil	25.9	cy	$ 35.00	$ 907.38
Furnish & Install Turf Grass Sod	115.2	sy	$ 10.00	$ 1,152.22
Unclassified Hauloff	243.3	cy	$ 20.00	$ 4,866.11
Drop Structure #1 & Channel Improvements				
Operate & Maintain Water Control	2.0	LS	$ 20,000.00	$ 40,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	1190.9	Tons	$ 85.00	$ 101,223.76
Furnish & Install Riprap Armoring (Type VH)	337.7	Tons	$ 50.00	$ 16,885.70
Excavate & Grade Native Alluvium	1325.2	CY	$ 22.00	$ 29,154.07
Furnish & Install Bedding Material	372.3	Tons	$ 30.00	$ 11,169.95
Furnish & Install Mirafi 180n Filter Fabric	953.2	SY	$ 8.00	$ 7,625.49
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	31.5	CY	$ 272.00	$ 8,568.97
Furnish & Install by Hand Washed Rock Veneer	13.1	Tons	$ 120.00	$ 1,567.62
Unclassified Hauloff	1325.2	CY	$ 20.00	$ 26,503.70
Drop Structure #2 & Channel Improvements				
Operate & Maintain Water Control	2.0	LS	$ 20,000.00	$ 40,000.00
Install Equipment Access Ramps & Roads	2.0	EA	$ 1,500.00	$ 3,000.00
Reclaim Equipment Access Ramps, Roads, & Staging Areas	2.0	EA	$ 2,500.00	$ 5,000.00
Furnish & Install Boulder (Avg 36" B Axis)	937.3	Tons	$ 85.00	$ 79,672.55
Furnish & Install Riprap Armoring (Type VH)	201.2	Tons	$ 50.00	$ 10,059.38
Excavate & Grade Native Alluvium	1017.6	CY	$ 22.00	$ 22,387.65
Furnish & Install Bedding Material	206.4	Tons	$ 30.00	$ 6,191.53
Furnish & Install Mirafi 180n Filter Fabric	534.4	SY	$ 8.00	$ 4,275.55
Furnish & Install Concrete Grout, Including Rebar, & Marine Epoxy	16.8	CY	$ 272.00	$ 4,579.21
Furnish & Install by Hand Washed Rock Veneer	7.1	Tons	$ 120.00	$ 846.06
Unclassified Hauloff	1017.6	CY	$ 20.00	$ 20,352.41
Additional Included Items				
Additional Excavator Time as directed by S2o	80	HR	$ 220.00	$ 17,600.00
Furnish & Install Large Climbing Structure	1	EA	$ 50,000.00	$ 50,000.00
Furnish & Install Small Climbing Structure	2	EA	$ 20,000.00	$ 40,000.00
Furnish & Install Kids Play Stream	1	EA	$ 75,000.00	$ 75,000.00
Furnish & Install Footpath Bridges	2	EA	$ 15,000.00	$ 30,000.00
PROJECT SUBTOTAL				$ 748,118.43
Contingency (15%)				$ 112,217.76
CONSTRUCTION SUBTOTAL				$ 860,336.19
Bathymetric/Topographic Survey				$ 4,301.68
Engineering Design				$ 34,413.45
Hydraulic Modeling				$ 8,603.36
Permitting 404, 401				$ 8,603.36
Permitting Floodplain				$ 8,603.36
Construction Bonding/Ins				$ 25,810.09
Mob and Demob				$ 17,206.72
Construction Stakeout				$ 4,301.68
Construction Monitoring				$ 43,016.81
TOTAL PROJECT COST OPINION				**$ 1,015,196.7**

Permitting

River parks, typically require Federal, State, and Local permits prior to the initiation of construction activities. Obtaining these approvals may require a number of tasks, including but not limited to:

- Detailed site survey;
- Wetland delineations;
- Historic structures and/or culturally significant resources surveys;
- Threatened and endangered species surveys;
- Establishment of a Proposed Conditions flood model; and
- Issuance of design drawings stamped by a licensed professional engineer.

Federal and State Permitting

River Parks within the United States require, at minimum, a 404/401 permit. This joint permit application involves a thorough review process, which includes an assessment of all impacts of the proposed park to the environment including an alternatives analysis demonstrating that the selected project is the least environmentally damaging and most practicable alternative. During this review, coordination with both the Virginia Department of Game and Inland Fisheries and the US Fish and Wildlife Service (USFWS) may be required. The following federal and state permits are anticipated for this project:

- U.S. Army Corps of Engineers (USACE) –Section 404 Individual Permit; and
- Virginia Department of Environmental Quality (VDEQ) - Section 401 Water Quality Permit.

Roanoke County

Depending on the location or locations of the selected project sites, various Roanoke/Bedford County development permits may be required. Coordination with the following organizations may be required as part of this process:

- Western Virginia Water Authority (WVWA);
- Town of Vinton Public Works for plans in east Roanoke County (TOVPW);
- Virginia Department of Transportation (VDOT); and
- Roanoke County Health Department (VDOH).

At minimum, a county floodplain development permit, as described below, should be anticipated for the Explore Park site:

- Roanoke and/or Bedford County Floodplain Development Permit.

Cities of Roanoke and Salem

For all project sites located within the municipal boundaries of either the City of Salem or the City of Roanoke, a local floodplain development permit should be anticipated. Obtaining approvals to construct within either the effective floodway typically require, at minimum, a no-rise certification, stamped by a licensed professional engineer within the State, demonstrating that the proposed improvements will not

increase the regulatory BFE or alter the delineated flood hazard areas. The following development permits are anticipated:

- Mill Lane site, City of Salem Floodplain Development Permit;
- Wasena Park site, City of Roanoke Floodplain Development Permit; and
- Tinker Creek site, City of Roanoke Floodplain Development Permit.

Process

This study has evaluated the sites and suggested possible design solutions that satisfy specific project site constraints and requirements and that would provide for a river based recreational attraction. This is not, however, a completed design that is ready to be constructed. Additional project phases including preliminary design, detailed design and final construction documentation are necessary before construction at the preferred alternative project sites can begin.

Design

Figure 35: River Parks are designed for many differing kinds of users.

River parks typically require several stages of design. The following outlines S2o's typical process from design through construction:

a) **Feasibility/Conceptual Design**—this is the first must-do part of a project. This phase is tasked with determining whether a particular project is possible and, if so, how it could look and function and what the approximate costs of the project would be. If done right this part of the project is very powerful as it provides the client with the materials necessary to pursue funding and grants and documentation useful for preliminary public process and stakeholder coordination. Deliverables include a feasibility report outlining project site opportunities and constraints, tasks

for completion, and permit requirements along with conceptual design drawings and budgetary cost estimates.

b) **Preliminary Design**—this phase gets to the heart of the design elements of project. If the Feasibility phase is about identifying what needs to be done to complete a project, Preliminary Design is about doing them. It is a phase tasked with completing the necessary actions required to finalize the design functionality and layout and to gather and process the data necessary to undertake detailed design. Preliminary Design often includes all of the tasks related to preparing for permitting, surveying, creating baseline models, meeting with stakeholders and agencies to define constraints and objectives, and completing design documents to the permitting level.

c) **Permitting**—permitting is a process that permeates most of the design phases. It is typical to work with regulatory authorities during the preliminary design phase to establish criteria and priorities for the project. Permit applications are typically submitted following the completion of Preliminary Design. Some permits, as outlined below, have lengthy review times for specialty projects such as river parks.

d) **Detailed Design**—the detailed design is about getting to the nuts-and-bolts of the project. Now that the project has been defined and adapted to the constraints and objectives laid out in Preliminary design the project is ready for detailed calculations and modeling. Often the level of computations and modeling is defined by the nature of the project. In some cases, such as the Holme-Pierrepont River Park, the project can be accomplished with 1-dimensional modeling. In other cases, such as the Calgary River Park, detailed physical models were undertaken.

e) **Construction Documentation**—this is the "after-design" phase. Documents are created that help define the project for the contractor including all sections, details, specifications and bid items. Often the River park designer will work with the client or the community to step through these processes.

f) **Project Bidding and Construction**—the project is put to bid by the project owner and a contractor is selected and contracted.

g) **Construction Oversight and Inspection**—in this phase the contractor and the design team work together to build the project to our exacting specifications. Often we have representatives in the field virtually full-time to ensure an accurate build that is aesthetically beautifully and highly functional!

h) **Course Commissioning**—the final phase and the one where we finally get to get wet! Paddling experts get in the water and test the project, often tuning wave characteristics and project features until the project is fully functional and meets design objectives.

The process of design is informed by the input from the project owner, local stakeholders, and regulatory agencies and is typically based on a standard of care that is evolving for this new industry.

Construction

Once detailed construction drawings, specifications, and bid information have been developed and the permits have been obtained, construction of the project may begin. The anticipated construction timeline for each of the concept plans described above ranges from three to six months, depending on the number and size of the drop structures proposed, along with the overall complexity of the total project area

improvements. In-channel construction activities typically occur when the flows are at seasonal lows and when there is the least impact to aquatic species. Further analysis and coordination with the Virginia Department of Game and Inland Fisheries and/or the USFWS will be needed to identify preferred construction windows for the project sites.

Conclusion

A number of In-stream Parks have been proposed along the Roanoke River and Tinker Creek near Roanoke, VA. This study has evaluated each of the sites and presents site-specific information and conceptual designs at each of the proposed project sites. Generally, the study finds that the parks are feasible and can be created subject to technical feasibility with regards to floodplain modeling in the reach. There are some issues, such as land ownership, which can present challenges at some of the sites—particularly Mill Lane. These issues should be resolved prior to proceeding with preliminary design. A general challenge to intermediate to elite boating is flow rates. The parks can be created and can be used at the proposed lower flow rates, however, at these rates the parks will likely be an attraction for tubers and inexperienced visitors, but would not be an attraction to kayakers in comparison to whitewater opportunities in the region. At these lower flow rates the parks will primarily function as low-flow float channels for local tubers and kayakers. At higher flows the features will grow in power and complexity and will begin to be an attraction to boaters.

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