



## *(One) Last Chance*

***NORTH DIVERSION CHANNEL OUTFALL AREA  
DESIGN PROPOSAL  
AMOS OAK ARBER  
MLA THESIS  
5/11/09***

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## ***Introduction***

This study looks at the interstitial areas between stormwater systems and their eventual outlet into larger bodies of water. The goals of this study are to determine best management practices (BMP's) for removing Albuquerque's stormwater pollutants just before entering the Rio Grande. Proposals for cleaning storm water will occur at the North Diversion Channel (NDC) Outfall Area, which serves as a settlement and flood control area, for most of Albuquerque's extremely altered watershed. This project proposes a strategy to retrofit the NDC outfall area, with the goals to create a multifunctional bio-filtration marshland facility that reduces volume, velocity, and contaminant migration. The project hopes to create an engaging open space that accommodates recreation, increases public awareness of natural systems, infrastructure, that is connected to the existing trail systems, in place of the single-function, restricted access, settlement area that currently exists. This site is important in that it represents the last chance to clean contaminated stormwater before entering the receiving waters of the Rio Grande. This site is in a beautiful location within the Bosque, and features unimpaired views of the Sandias. Unlike other stormwater facilities in Albuquerque, this site has high visibility, due to several roads that cross over it, thus providing opportunities for exposure to sustainable infrastructure and thus helping to increasing awareness of its importance.

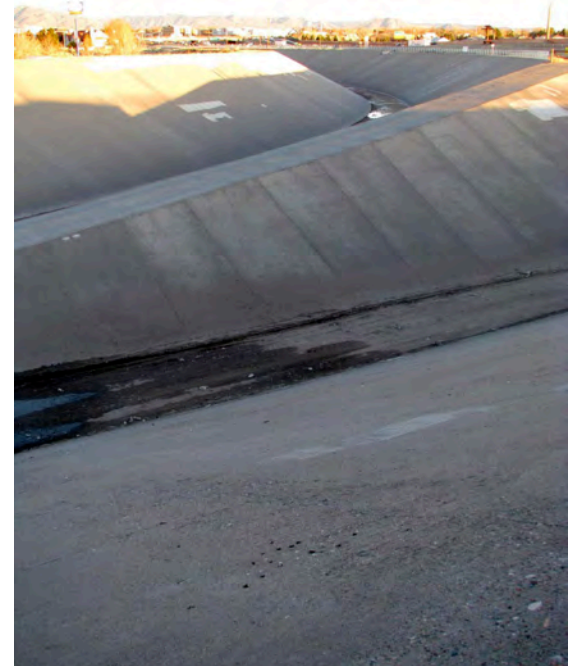
Current storm water practices throughout the world including Albuquerque, New Mexico are beginning a paradigm shift. Much of the storm water infrastructure constructed by the Albuquerque metropolitan arroyo flood control authority (AMAFCA), is designed for the narrow purposes of protecting life and property. While these objectives are extremely important the resulting facilities divert water, and the contaminants it picks up, as quickly as possible into the receiving waters of the Rio Grande, limiting human understanding of, and interaction with storm cycles and the importance of infrastructure to our daily lives. The shift that is slowly occurring in Albuquerque and beyond, is focused instead to take advantage of the multiple opportunities that stormwater management presents including; water quality improvement, reconnecting with infrastructure services, habitat and open space creation, community involvement, artistic interpretation of natural processes, and increased stewardship for the urban landscape.

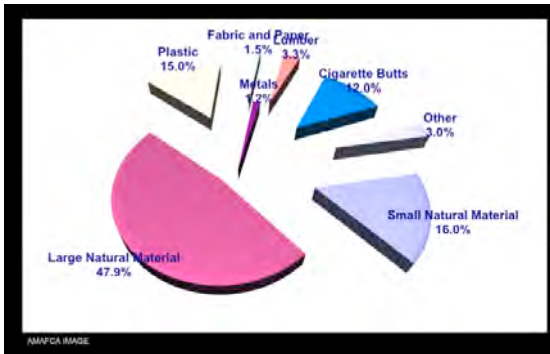
### ***Current stormwater management in Albuquerque***

Although changing, the public's general attitudes for storm water management are indifferent; out of site, out of mind. Current stormwater management practices reinforce this attitude with massive stormwater collection and treatment systems rather than multiple small ones that deal with treating waters at their source - point source treatment (Campbell 1999). Conventional systems of dealing with stormwater in

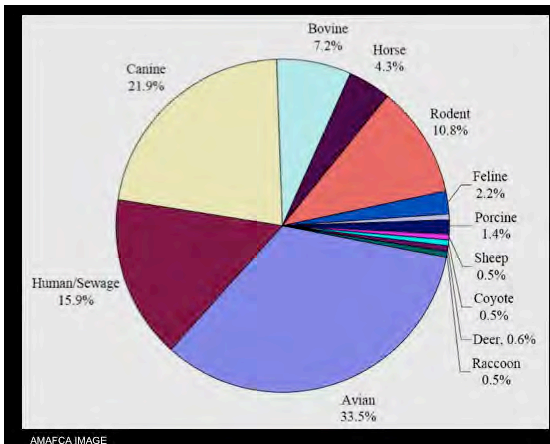
Albuquerque typically involve rather unattractive industrial looking concrete and steel structures, that usually have no functions except those related to moving or holding water. The large concrete lined arroyos in Albuquerque typically conjure a negative image, except by skateboarders and graffiti artists. These huge structures typically do not allow for opportunities for groundwater recharge and only offer very limited benefits to plants and animals, and people (Thayer 1994). These facilities are a result of urban development in order to control flooding and damage caused to property from naturally shifting water-ways. Be that as it may, Albuquerque has this expensive infrastructure which has allowed for the development of areas that could not otherwise be built due to the dangers of flooding, therefore retrofitting this system makes economic and functional sense.

Urban stormwater runoff is a large source of water pollution worldwide. Urbanization and the impermeable surfaces associated with buildings, roadways, and parking lots do not allow for infiltration that would naturally exist. On undisturbed forested land, stormwater is held by the soil or infiltrates into the ground resulting in very little runoff, while in urban areas runoff estimates are as high as 85%. In highly developed areas the majority of the water has to be directed elsewhere (Hough 2004). As stormwater moves over the urban environment, it picks up and carries along a host of pollutants such as pesticides, herbicides, sediments, trash, oils, gasoline, heavy metals, animal waste, bacteria, and excess nutrients. These pollutants are eventually deposited into receiving waters such as the Rio Grande, water which millions of people depend on for a host of uses. The results from increased pollutants cause a wide range of





problems including: algal blooms, fish kills, degraded drinking and irrigation water, degraded wildlife habitat, and diminished recreation qualities and aesthetic appeal (Dunnett and Clayden 2007). In high altitude arid areas such as Albuquerque, storms are infrequent and sudden and problems with pollutants are intensified, as pollutants are accumulate on impermeable surfaces, causing the “first flush” of storm water to become highly contaminated (Campbell).



Attempts to address stormwater first began in the US with the 1972 clean water act. Initially, however state and federal regulations focused on storm water quantity and flood control, and did little to improve quality. In 1987 an amendment to the clean water act addressed pollution, this lead to the widespread development of stormwater best management practices (BMP's). BMP's include structural, operational, and educational practices aimed at limiting the transport and discharge of pollutants through stormwater. Examples of commonly used BMP's include dry detention ponds, wet ponds, stormwater wetlands, vegetated swales , Infiltration trenches, and porous pavements. An on-site stormwater BMP ‘treatment train’ or matrix applied to private property on a wide scale, would have the effect of reducing the water volume, speed, and pollutant concentration on large scale flood control infrastructure thus limiting the need to continue building facilities at such a large scale, one study found that these practices can reduce run off at least 40%. Until every property has a stormwater ‘treatment train’ our rivers continue to receive large amounts of pollutant laden stormwater. This study hopes to provide a proposal that will tackle more immediate remediation of this problem. At the site, that is the last point in the system, before most of Albuquerque’s stormwater reaches the Rio Grande. Furthermore, this projects hopes to serve as a model of sustainable infrastructure while exceeding NPDES compliance and EPA clean water act regulations.

### ***Wetland loss***

The previous sections have addressed stormwater management practices and their implications as background and support for the proposed use of debris removal

structures and bio-filtration marshlands at the site. Other reasons to consider the construction of a bio-filtration marshlands are the issues of wetland loss, functions, and creation. Any opportunity to mitigate this habitat loss should be considered

Historically wetlands have been misunderstood and mishandled. There has been a net loss of half of the original 197 million acres of wetlands in the US (France 2003). In some states 50%-90% of the wetlands have been destroyed due to agricultural practices, development and construction (Sorvig 2008).

Although reports vary, from one third through to more than three quarters, a huge amount of New Mexico's wetlands and wetland associated habitats such as rivers have been destroyed or degraded (NWF 2001). Other reports state, that from 1918 through 2004, up to 93% of Albuquerque's Middle Rio Grande Valley Basin wetlands were lost (Army Corps of Engineers and CWSGR 2004). In the arid southwest these losses are particularly damaging where water is in limited supply, and some 55% of New Mexico's wildlife species including 25% of the state's threatened and endangered species are dependent on aquatic, riparian or wetland habitat for survival (NWF 2001) especially since riparian areas occupy less than two percent of the New Mexico landscape (Terrell T Baker 2003).

### ***What are wetlands?***

A general description of wetlands is an area that is wet, long enough each year, to produce soils that favor emergent plants with specific adaptations to living in oxygen-poor soils (EPA "Definitions"). Wetlands are a critical link within the water and food-webs that create extremely active locations for species that live in various biomes. Wetlands consist of a combination of wet and dry areas; and often contain areas that are essentially terrestrial habitats. Especially in New Mexico, wetland habitats are not generally stable and are dependent on periodic inundation and drying. Wetlands are dynamic, transitional systems that vary from deep-water to complete drying, containing plants and animals that are specifically adapted to these conditions





(Hammer 1997). Wetlands perform multiple functions that are still becoming fully recognized in human terms such as: Water cleansing through physical, chemical, and biological processes, groundwater recharge, flood and erosion attenuation, biological productivity and diversity, recreational and aesthetic value (Campbell and Ogden 1999, Thompson and Sorvig 2008).

### ***Constructed Wetlands***

For the purposes of this project proposal I will use the term “constructed marshland” rather than constructed wetland. A marsh is similar to wetland but it does not fall under the jurisdictional protection of the Freshwater Wetland Protection Act, therefore limiting design and maintenance flexibility (NJSBMPM 2004).

Wetlands provide a wide variety of functions and exhibit many different forms. Although constructed marshlands can perform many important functions, they are unlikely to perform all of the functions of a natural wetland; therefore the specific desired functions of system will determine the type of wetland that is constructed. A wetland constructed to offset habitat loss will be different than one constructed to remediate stormwater (Sorvig 2007, Hammer 1997). Like other types of ecological restoration projects it is important to formulate clear, measurable goals, reflecting specific site conditions and functional objectives.

A new mode of thinking or design paradigm shift concerning the built environment is becoming increasingly prevalent in the design and planning community. While individual approaches may differ somewhat, the following sections highlight some of the common threads within current thinking on sustainability in the landscape, and their implications for stormwater management practices.

### ***Multi-functioning***

Multi-functionalism is key to the development of sustainable practices. Designers are beginning to question single-use spaces and facilities. In the case of stormwater



management, we have a need to protect life and property, and reduce receiving water pollution. Rather than merely slowing and holding water, this public resources of space and water could give us the opportunity to create habitat, purify water, create public open space, and educate.

### ***Interaction and reconnection***

Sustainability advocates and theorists agree on the notion that in order for sustainable practices to be understood and accepted, they must be visible and present on an everyday basis and in everyday situations. Thayer (1994) proposes that a critical purpose of the sustainable landscape is to expose people to sustainable principles in “discreet, manageable chunks” (309). Designers of the built environment may be in a unique position to reach mass audiences by shaping the places that people interact with everyday. Increasing people’s awareness of their environments and celebrating the beauty of the everyday are important tools in fostering pride and stewardship of local landscapes (Hester 2006). Nassauer (1995) suggests that revealing ecological complexity in everyday situations has much greater power to convince than confrontational or preachy approaches, and will lead to sustainability.

Stormwater marshlands represent a powerful medium for everyday exposure to, and engagement with, sustainable practices. As addressed above, current wastewater systems limit our understanding of natural and infrastructural processes and stormwater treatment is generally kept out of sight. By contrast, creating attractive and engaging stormwater catchment and treatment areas that are visible and accessible on an everyday basis can encourage understanding and acceptance of new, more environmentally friendly techniques. These systems can promote awareness in multiple ways; plant growth and development encourage observation of seasonal change and conditions; changing water levels reflect available water supply; and wildlife observation helps to reconnect us with our surroundings. The NDC Outfall site presents great opportunities for public exposure; as it has high visibility due to several bridges that cross over it and it exists in the beautiful setting of the Bosque







with great views of the Sandia Mountains.

Constructing a multifunctional stormwater marshland in place of the existing single-function settlement area at the site represents a move from a model of simplicity and homogeneity to a model of complexity and diversity. This constructed stormwater bio-filtration marshland will encourage consideration of the site's place within a larger ecosystem and the connection between site-specific drainage conditions and the larger watershed. Water filtering by plants and microbes and water infiltration into the soil will foster vegetative growth, attract other life forms, connecting human activities to natural processes, thus contributing to the overall health of Albuquerque's urban landscape.

Besides reconsidering our relationship to ecological processes, is the need to reconsider our views on, and use of resources. Rather than seeing water as something that we pay for and expect to come out of the tap, we might understand it in terms of the multiple benefits that it can provide both to us and to other forms of life. For example, in a constructed stormwater marshland, "waste" water helps to create wildlife habitat and humans, in turn, derive great pleasure from wildlife (Hester 2006). Considering stormwater runoff not as nuisances or waste that must be dealt with, but as a resource for improving our urban landscapes, can be a simple, yet powerful, step towards maximizing our use of locally available materials to add value to our daily environments.

### ***Disassociation and Disconnects***

Our current urban forms and lifestyles have removed us from contact with nature. Obscuring our awareness of everyday natural processes negatively impacts decisions about our urban landscapes, and our ability to see ourselves within the larger context of our surroundings. The constructed bio-filtration marshland system proposed for this site will provide opportunities for work days, clean-up events, seasonal celebrations, and daily monitoring activities that not only promote stewardship, but can also become

community rituals that help us to mark and observe natural changes in the landscape over time.

Similar to our general disassociation from nature, we have also become profoundly disconnected from our infrastructure systems and services. Strang (1996) argues that we are not only removed from and understand little about our infrastructure, but that we have designed our cities to deny and disguise the very systems that make our lives possible. We must explore the opportunities for meaningful design that are represented in our infrastructure systems, in order to strengthen local identity and reacquaint us with the importance that infrastructure has in our lives. Specifically, Strang suggests that the biggest gains can be made in addressing single-use infrastructures, creating, for example, urban stormwater drainage that serves also as open space and a working biological system by uniting the two to perform multiple functions.

Many theorists like Strang, contend that infrastructure done well has the power to heighten our sense of place and add value to the surrounding landscape. They argue that the traditional engineering approach to infrastructure design denies the richness of natural systems and breaks existing connections between plant and animal communities. Replacing a single-function flood control area with bio-filtration marshlands represents a move from a very simple system to a more complex one that reveals the relationships between natural and human systems.

### ***Aesthetics, Ecological Process, and Creativity***

A perceived schism between ecological design and aesthetic design has resulted in the development of new theory and approach towards a culturally responsive ecological aesthetic. While ecological processes must serve as models for and inform the urban landscape, this should by no means preclude artistic interpretation and the principles of aesthetically good design. Thayer (1994) states that “sustainable landscapes need not be austere, solemn, dictatorial x-rays of ecological processes





blaring across our consciousness” and that they should not be “devoid of fun, fantasy, and human imagination” (313). Emphasizing the importance of design techniques such as metaphor, contrast, and reiterated forms can give perceivable order to the complex and often invisible processes of nature (Mozingo 1997). She points out that too often ecological design is meant to ‘look natural’ and so is treated as a preserve, fenced off from public access with little or no attention given to the detailing of the points of human interface.

Nassauer (1995) recognizes the need to approach ecological design through an appeal to human nature rather than a confrontation. Nassauer observes that “ecological quality tends to look messy” and that this makes ecologically functional designs susceptible to misinterpretation as unintended or unkempt (161). She stresses the importance of the look of human intention. These indicators of care and intent can be as simple as bird houses and feeders, mown frames or access strips, and well-maintained fences and structural details, but have great power in making ecological designs approachable comprehensible.

### ***Ecological Design and Site Specificity***

Some of the exciting and inspiring characteristics of good ecological design is its inherent site specificity. If created in response to specific site conditions, no two ecologically informed designs will look alike. As Relph (1993) states, we can reclaim place identity through a careful response to conditions, rather than copying previous approaches.

Site identity can only take on true meaning through, people’s interactions with it. Access and engagement are keys to the experience of ecological design sites. For example, creating picnic shelters alongside constructed marshlands or interspersing parking with stormwater collection swales will place these technologies in sites of daily human activity. As Thayer (1994) writes, “observability speeds the adoption rate“ of new technologies (192).

## ***Adaptive Management and Accepting Change***

An essential component of good ecological design is the awareness and acknowledgement of change (Mozingo 1997). Thompson and Sorvig (2008) see change as an inherent part of any landscape and landscape maintenance not as a way to keep things the same, but as a response to change. They view maintenance as such an important component of sustainable design that they have devoted an entire chapter of their book “Sustainable Landscape Construction” to its promotion. Particularly, Thompson and Sorvig argue for considering maintenance from the start of a design project, rather than as an afterthought once a design has been completed. By designing stormwater marshlands with future maintenance needs in mind, we can design systems to be largely self-maintaining and keep costly, labor-intensive upkeep to a minimum. This design proposal will consider this aspect of ecological design carefully do to the need of dealing with the pollutant laden sediment and debris that are collected here in large amounts.

## ***Aridity***

The vast majority of constructed wetlands projects have occurred in climates with average to high annual precipitation rates. We can learn from these sources, but it is important to remember that arid lands will have some of their own particular concerns and challenges. The combination of sudden high-volume storms and long, dry periods in the arid West is a problem that has not yet been properly addressed.

However, contrast in arid regions between areas receiving water and their dry surroundings can be very dramatic. In many cases, a little water in the desert goes a long way in creating suitable habitat for native plants and animals. An understanding that wetlands need not be consistently wet and may, in fact, be dry for certain years or seasons, is important to keep in mind for arid land constructions (Hammer 1997). Importantly, the number of ‘accidental’ stormwater wetlands that can be found along ephemeral drainages throughout Albuquerque support the feasibility of their implementation on a larger scale in our climate.





### ***Natural as Model***

Local natural wetlands are the best models for planning new constructed marshland projects. As France (2003) suggests, humans can learn a great deal from “the self-designing capacity of nature” (27). Careful study of natural wetlands adapted to the regional conditions can potentially increase constructed wetland success rates.

In Albuquerque, the most appropriate local and natural models are the spring-fed wetlands or cienegas. These systems maintain a permanently wet core due to water supplied by a spring, while the surrounding area experiences periodic inundation and drying in response to precipitation run-off (Linderoth-Hummel 1999). At the site, nuisance water may serve as the equivalent of the spring source for maintaining a wet core, while Albuquerque’s volumes and seasonal patterns of rainfall determine the hydrology of the surrounding wetland area.

Formulating clear and specific goals will also help to determine the form and approach taken in wetland construction. As addressed above, constructed wetlands can serve many functions, but will be most successful if they are designed with specific functional objectives in mind. Potential goals range from water purification to habitat creation and will likely provide multiple secondary benefits.

Wetland plants are the feature that most commonly characterizes a wetland in people’s minds. They are also often the best indicator of the existence of a natural wetland, as they are specially adapted to survive in the anaerobic environment of wetland soils (Hammer 1997). Wetland plant types vary widely and are adapted to distinct micro-conditions found within the wetland environment. Six major planting zones exist in typical wetlands: open water, deep marsh, shallow marsh, wet meadow, shrub wetland, and forested wetland. These planting zones support five major growth forms of vegetation: free floating, anchored, submerged, emergent, and woody (France 2003).

Although many constructed wetlands are planted with only a few plant species or a monoculture, Wetzel (1993) points out that natural wetlands do not consist of monocultures and argues that wetland designers should follow natural models. Incorporating a variety of plant types has been shown to provide more effective wildlife habitat, absorb more water, and treat water contamination more effectively than planting a monoculture. Shading of the water surface by larger plant species will help to reduce evapotranspiration rates and reduce the likelihood of algal blooms (Dunnett and Clayden 2007). Importantly, a variety of vegetation types will also add to the aesthetic appeal of a constructed wetland.

Natural wetland system flora are composed of Macrophytes, or large aquatic plants, and microbes. Macrophytes support microbes with organic matter, while microbes provide macrophytes with the nutrients necessary for survival. Wetland plants have special structures called aerenchyma, which allow them to survive in oxygen-depleted conditions that would kill other plants. Anaerobic soils and adapted plants' roots create a reducing environment in which toxic ions can be re-oxidized and precipitated into the soil, allowing wetlands to act as 'sinks' for a number of potentially harmful substances (Campbell and Ogden 1999, Hammer 1997).

Plants selected for the site will be based on those found in local natural wetlands. Consulting local examples will guide my choices about plant species and densities that are adapted to our regional conditions. Selecting plants that are known to tolerate both inundation and drying will be important for the stormwater zone, while the wet cores will allow for the use of floating and submerged plant types. Planting selections should be based on native species and will strictly avoid any species known to be invasive in the State of New Mexico.

### ***Mosquitoes and Drowning***

Concerns about safety and liability warrant careful consideration, but should not be seen as deterrents to the bio-filtration marshland proposed for this site. Two primary



concerns are public access and insect breeding (WERF “GIDC” 2007). Safety concerns regarding accessibility can be addressed through a few fairly simple measures. Gentle, sloping banks help to create safe pond edges that make falling into the pond unlikely and getting out of the pond easy. Signage should also be used to educate visitors about the system’s functions and to encourage caution around areas of open water.

Several simple steps can also be taken to prevent the bio-filtration marshland from becoming a mosquito breeding ground. Mosquitoes breed in shallow standing water and it is essential to manage a constructed marshland to avoid areas of shallow water allowed to stand for more than 48 hours. If water cannot be infiltrated into the soil in that time, water should be directed to deeper ponding areas or treated with biological larvicides (WERF “GIDC” 2007). The nuisance water core in the proposed wetland system can also be stocked with mosquito fish (*Gambusia affinis*), a small, rapidly reproducing fish that feeds on mosquito larvae. Additionally, dragonflies will help to control mosquito larvae and bats and swallows assist in mosquito control. The installation of bat boxes and swallow nesting boxes around constructed wetland sites has been shown to have good results (Campbell and Ogden 1999).



### ***Design Considerations***

Aquifer depletion and infiltration in Albuquerque is an important and contentious topic, that is problematic due to water rights and specific geology that limits infiltration. Despite this, well situated wetlands do offer the most substantial means of infiltration. Potential infiltration at the site may only help to raise the water table, rather than the aquifer, but this could still have positive effects on the Bosque vegetation and ongoing restoration efforts to improve this unique ecosystem.

A storm water marshland can act as a heat sink, especially during the summer, and can discharge warmer waters to the receiving waters. The increased temperatures can affect sensitive fish and insect species (EPA 1999). Tree planting is important

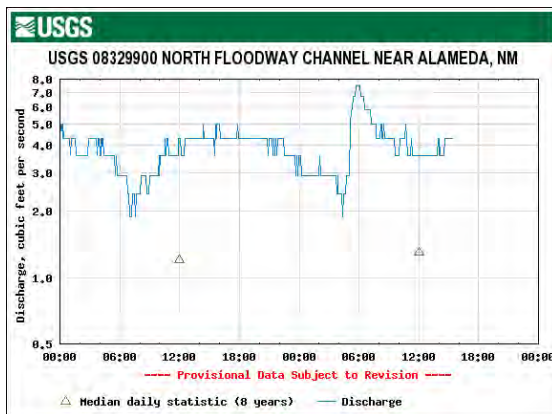
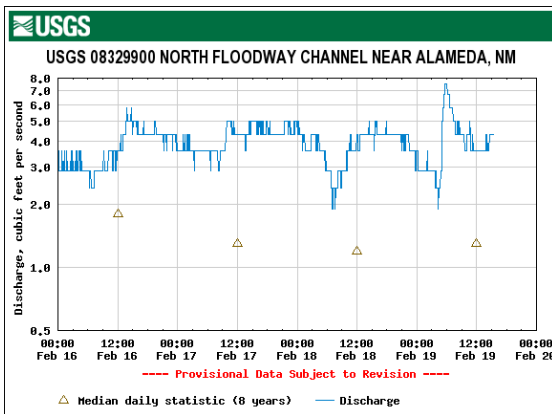
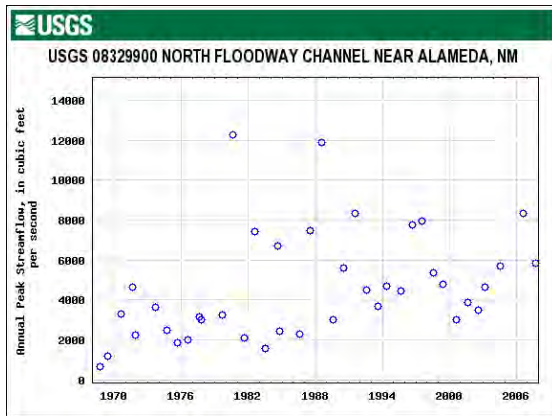
to offset this rise in temperature by shading the water and thus the potential for low dissolved oxygen sags in the Rio Grande. Tree planting can have the added value of habitat creation and buffer creation, increased aesthetic value, add to Bosque restoration efforts already in place, and help to restore hydraulic cycles of evapotranspiration.

Another consideration for this site and project is that the new Rio Chama drinking water project is only 2.5 mi. downstream from the site. Stormwater marshlands will reduce contaminants and potentially help to reduce filtration and maintenance costs of this drinking water purification facility.

AMAFCA considers the arroyos to be public space and therefore open to public use for various recreational activities. Pedestrians and cyclists regularly use this system for recreation and transportation which should be applauded but much more can be done, as they are mostly drab paths with little or no vegetation. Enhanced design and adaptive reuse of the channels could create a unique series of linear parkways, becoming a signature feature of Albuquerque. Studies have shown that linear parkways, greenbelts and nature preserve have strong positive impacts on the properties located near them including increased property values (Anton 2004). This project will propose the extension of two of the existing trails to form a loop at the site, thus creating a destination for trail users.

Many states and agencies have developed design guidelines for constructed wetlands. Some of the generic recommendations include: varying the depth, creating surge reservoir space, sediment bays, inducing meandering, and irregular edges. One type of constructed wetland that makes sense for this site is called the extended detention stormwater marshland. This type, features a large percentage of surface areas for storm surge above the normal water level to deal with flood control issues. A balance must be met of large 100 year storm predictions with the levels of smaller more common storms that contribute to the pollutant loads that enter the Rio Grande on a yearly basis.





## Albuquerque and water quality

The emphasis on flood control policy in Albuquerque has largely been to accommodate development and contributing flow volumes to the Rio Grande. Albuquerque's channels also contribute contamination. A 2004 study by AMAFCA and the USGS found that the system of drainage in Albuquerque is a source of concern because of potential water quality problems. The report found that nitrogen, phosphorus, cadmium, lead, copper, zinc, fecal coliform, and e. coli were all present in significant numbers (USGS 2004). AMAFCA's centralized system creates concentrated flows of contaminated water that is discharged into the Rio Grande, this proposal seeks to remediate this problem with a constructed marshland and a series of debris removal structures.

Compounding the pollutant loads that the NDC is contributing to the Rio Grande, is the time of Albuquerque's storm season and river levels. During the snow melt season of April through June peak flows typically occur in the Rio Grande within Albuquerque, at this time discharge rates of the North Diversion Channel (NDC) equal about one percent of the total flow of the Rio Grande. Compared to the rainy season in July, similar comparisons show that the NDC discharge equals approximately 59% of flow of the Rio Grande (USGS 2004). These percentages show that amount of contaminated stormwater is quite concentrated compared to the total volume of the water moving beyond Albuquerque. Designing means of trapping the contaminants in the stormwater for the flows that occur during the monsoon season will be crucial.

## Marshland Contaminant Removal Performance

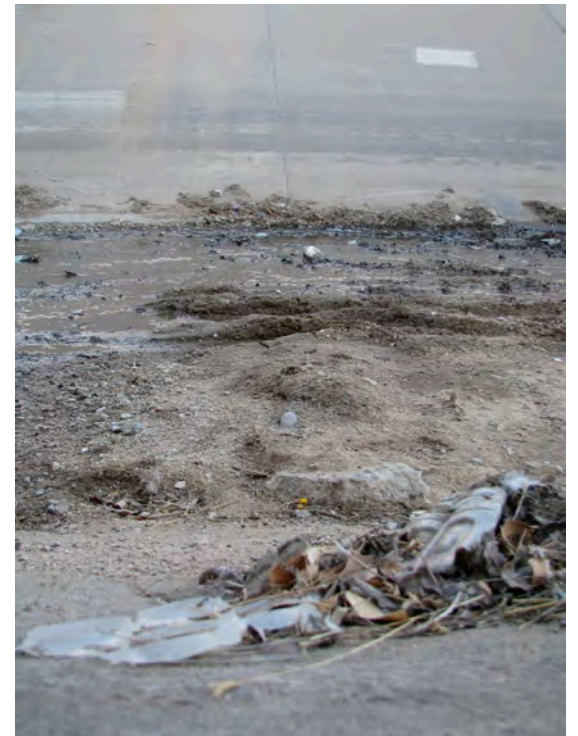
Marshlands remove pollutants from storm water through physical, chemical, and biological processes. Chemical and physical assimilation mechanism include sedimentation, adsorption, filtration, and volatilization (EPA 1999). The main factor influencing removal is sedimentation. Manipulating velocities through the wetland and thus contact time with vegetation are extremely important design considerations

in these systems, the longer the time stormwater is allowed to settle the higher the rate of contaminant removal. Many pollutants are removed as they become attached to particles of debris, sediment, or vegetation and its root system which is referred to as adsorption. A concern especially important to our region is the re-suspension of pollutants during storm events of particles that have previously settled out. Other process that help to remove contamination are biological process, as a result of uptake by plants and algae (CWP 1997).



While different study results vary one conducted in Florida evaluating the effectiveness of constructed wetlands at four different sites found that constructed wetlands, that were designed and constructed specifically to remove pollutants from surface water runoff, typically remove suspended solids in excess of 90%. Removal rates for total phosphorus ranged from 50% to 90%, while nitrogen removal was highly variable ranging from 10% to 76% (Tanner and Sukias 1999).

The psychology of littering habits is quite interesting and information campaigns should also be considered for BMP's addressing the contaminants that Albuquerque contributes to the Rio Grande. Changes in public policy, can have unexpected effects toward littering for instance, smoking bans in public bars, might contribute to increased littering resulting in more butts in our waterways.



### ***Accidental Habitat***

In locations throughout the AMAFCA channels, wetlands have begun to appear unannounced and unintended. Their emergences are an encouraging precedent for an adaption to the current form. The presence of accidental wetlands within the AMAFCA channels begs the question, why doesn't this happen on purpose? The amount of water and performance of wetlands in mitigating the destructive combined forces of volume, velocity and contaminant migration suggest that constructed wetlands would be logical approach to managing storm water throughout the city.



The presence of water, even in periods with no immediate precipitation, within the channels is currently termed “nuisance” water by AMAFCA. Estimates for this flow are between 2-5 cfs which is down from twice as much 5 years ago (AMAFCA). This nuisance water, however, could be utilized to create wet cores for treatment marshlands inspired by local natural spring fed wetlands or cienegas.

### ***Facts about the NDC outfall area***

The NDC is 9 miles long and serves area that is about 110 square miles of Albuquerque's watershed. This structure has the potential to 10 square miles of Albuquerque's watershed. Nuisance flow rates range from 2-5 cfs in the channel to the Outfall area everyday. Sediment and debris has to be removed very quickly to prevent blockage and failure of the system. Over 300,000 cu yd of sediment has been removed from the outfall area since 1968. This sediment contains many pollutants and can not be used as fill material. Sediment from the outfall area that is removed first has to dry for 6-8 weeks before it can be stockpiled. This facility sits on a 2000' easement of pueblo land, and is subject to Pueblo water quality standards. Cleared-out areas on the sides of pilot the channel are highly disturbed and subject to invasive vegetation such as Tamarix and Siberian Elm, which neighbor Bosque restoration efforts. UNM student research discovered dissolved oxygen sags in the Rio Grande resulting in fish kills, although not fully understood, this is probably a result of stagnant water in the pilot channel being pushed out during storm events, and has resulted in fine threat from the EPA (AMAFCA 2009).

### ***Litter removal devices***

AMAFCA is currently designing and constructing many devices within the feeder arroyos to remove debris. These efforts are expensive and require a lot of effort, but they do help to add to their BMP's, and needs to meet their environmental quality permits. These efforts are amenable and go beyond what many other states agencies have attempted (Coonrod 2009).

**NDC FLOOD WAY WATERSHED = 110 SQUARE MILES**



CENTRAL & YALE

I-40 & TRAMWAY

4TH STREET      NDC FLOODWAY      BALLON FIESTA PARK      I-25 & TRAMWAY



PIOLET CHANNEL      ABQ DRAIN      NDC FLOODWAY APPROX 9.25 ACRES      RAILROAD BRIDGE      EDITH BLVD      ROY AVE.



4TH ST

"BATHTUB"

SEDIMENT PILE  
300,000 CU/YD SINCE 1968

BALLON PARK

PIOLET CHANNEL      DIVIDER      ABQ DRAIN      IRRIGATION DITCH



4TH ST.

"BATHTUB"

EDITH BLVD



Litter or gross pollutants are removed by various methods grouped into two categories: Structural methods such as traps installed inside stormwater channels, and non-structural methods that involve changing the attitudes and actions of the community. Some common structural devices used in Albuquerque are baskets below entry of inlet pipes, water enters the baskets flows out through the holes, while debris larger than the pore size is retained. As debris builds up, it reduces the pore sizes, allowing smaller material to be caught. Trapping efficiencies of 30 to 80 percent have been reported, depending on cleaning frequency (Allison, Chiew and McMahon). The trash rack is another common device that works on similar principals as the basket they are large fence type structure that are installed across stormwater channels. They are also manually cleaned, and as material builds up overflows can carry pollutants downstream (Allison, Chiew and McMahon).

No litter trap is 100% effective and the balance between cost and effectiveness is important in considering designs for these structures. The construction and maintenance of large numbers of smaller traps will almost certainly be greater than the construction and maintenance of one or two larger traps (Armitage). Ease of cleaning is crucial. Trapping efficiency will rapidly fall to zero if the traps are not properly maintained, and proper access must be provided.

*Review of several AMAFCA gross debris removal devices*

AMAFCA is quite unique in using BMP's for in channel storm water quality devices, very few agencies throughout the world are attempting what they are within the conditions that exist in Albuquerque.

*Trash basket below outlet into NDC near I-40 from Girad Blvd.*

This is one of AMAFCA's earliest BMP's in the form of a storm water quality device (SWQD). This type of device is only effective if cleaned regularly, as the screen gets clogged with debris such as leaves and pine needles the holes get smaller and smaller severely limiting flow. Maintenance at this site seems difficult do to several factors such as debris forced into the screen and the severe steepness of the channel



sides.

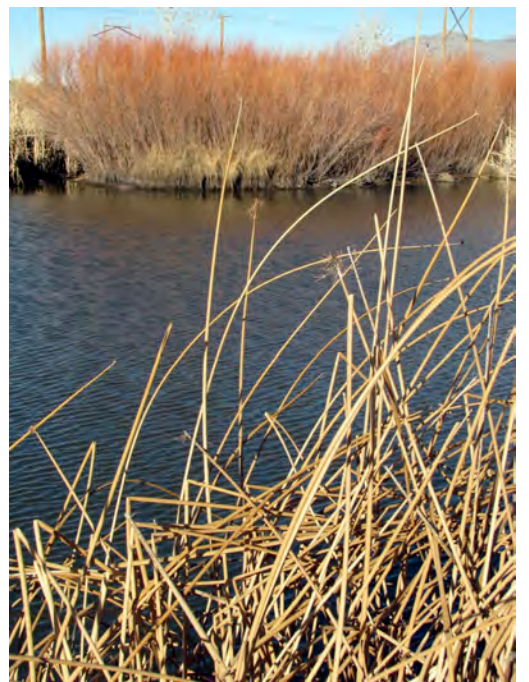
### *Bear Canyon SWQD*

Bear Canyon is one of Albuquerque's naturally existing arroyo's that is currently a combination of lined and unlined arroyos which accommodates large flows originating in the foothills. Prior to Bear Canyon Arroyo's outlet into the NDC, AMAFCA has constructed a series of debris screens to capture gross pollutants. The facility consists of a concrete channel structure that funnels flow towards a steel fence followed by a row of dumpster-shaped boxes constructed of vertical bars. The Idea is to allow a garbage truck be able to unload the "dumpsters" directly into the garbage truck rather than using a loader, to remove the debris, which then has to be hauled to the landfill. While the screens seem to be effective in removing large debris, sediment does not have a chance to drop out. Up and downstream from this removal device, exists unlined portions of arroyo that are filled in with vegetation such as the Coyote Willow. These areas seem to capture sediment and large debris, that bypass the structure quite well. Investigating means of managing vegetation to captures debris will be important for my project.

### *South Pino Arroyo outlet*

This facility consists of a series of two basins that serve to remove pollutants, as well as provide wildlife habitat, and slow flows before entering the NDC. The flow from several smaller arroyos is directed into a basin that is drained from an incline port outlet tower. This system is commonly used by AMAFCA to slow flows, encourage, settlement, and restrict debris from moving downstream. Following the first basin the flow goes to a constructed pond that is lined by thriving Cottonwood trees, Cattails, and Rushes. Although it has not rained for months the bottom of the pond was still damp and muddy. Despite its small size this pond provides great habitat for birds and wildlife, also significant amounts of sediment have been left behind rather than going into the Rio Grande.



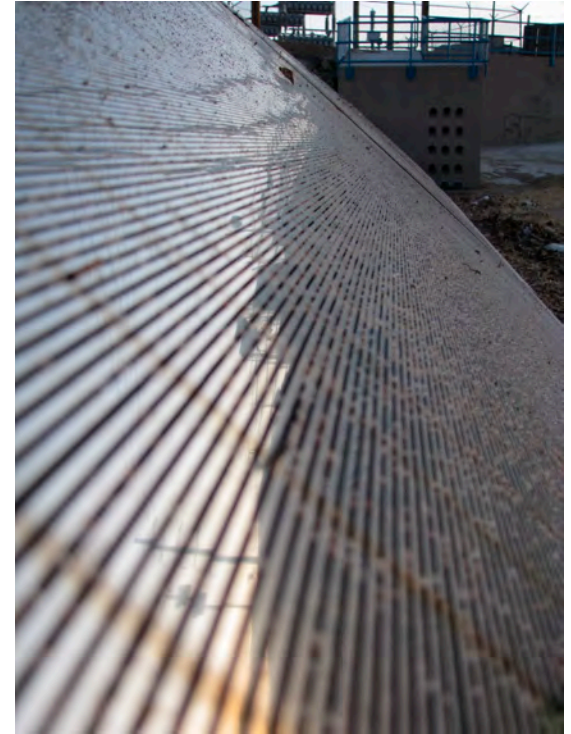


### *Vineyard SWQD*

This is a recently constructed facility that utilizes a Coanda filter screen, inclined port spillway and settlement basin. The Coanda screen separates water from debris and is capable of screening out fairly fine particles. After passing over the screen water is directed into a small basin that utilizes a small inclined port structure before continuing on to the NDC. It does seem problematic that the arroyo is unlined just before the screen, which allows lots of sand and fine particles to be pushed into the screen thus reducing surface area, and effectiveness. The small settlement basin is extremely steep, due to space restrictions, seems prone to erosion, and difficult to establish vegetation, thus limiting habitat and biological filtration.

### *North Pino Arroyo SWQD*

This facility seems to be the most advanced and efficient in removing debris. An intake structure located within the channel, directs flow to a debris removal system. This system uses a baffle and weir design that forces large debris to fall-out prior to flow being directed over a Coanda screen, and allows for ease of maintenance of removing the debris. The water is then moved into a beautiful permanent pond area that allows for dissolved sediment to fall out. The pond is thriving with Rushes, Cattails and lined by Cottonwood trees. This pond provides great habitat and is quite beautiful despite being surrounded by heavy industrial facilities. Although access is not restricted this location, it is difficult to get to except by walking, also it is not visible from the paved bike trail on the NDC. The success and beauty of this spot rivals constructed wetlands such as Tingly Beach. It should be promoted more, and perhaps have some amenities such as benches or shade structures for people.



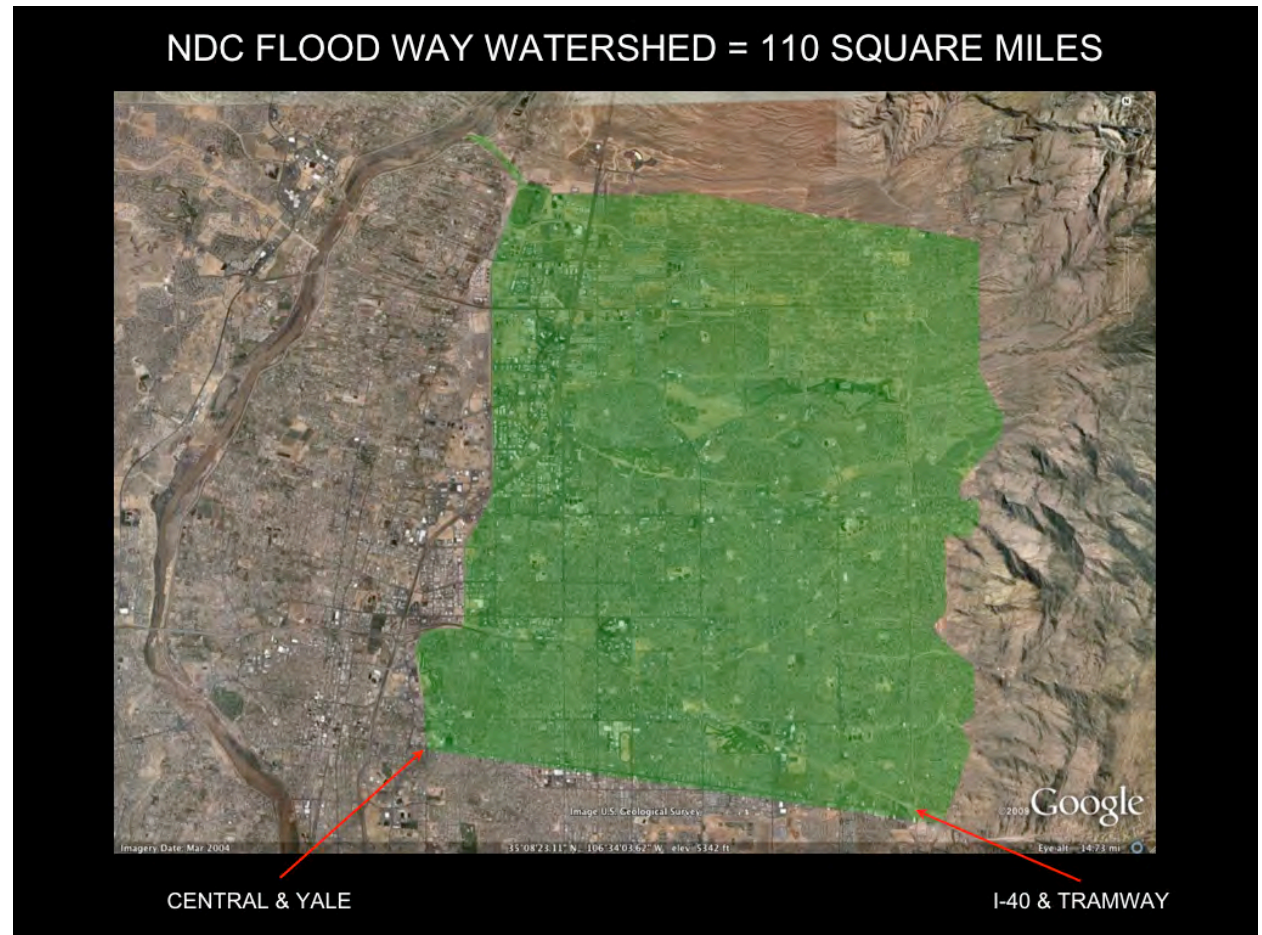
### *Conclusions*

Bio-filtration marshlands for Albuquerque's point of stormwater release should be modeled on spring-fed wetlands, consisting of a permanently wet core fed by nuisance flow and a flexible extended detention surrounding area fed by stormwater runoff. Plant selections should be based on native species available locally and should represent a wide variety of species in order to maximize bio-diversity and habitat richness. This projects will be designed with specific goals in mind, but must also be allowed to adapt and change in response to external conditions and ease of maintenance. Local examples of using stormwater BMP's do exist, and are successful, this proving the plausibility for creating a multi purpose bio-filtration marshland at the NDC outfall area.





## ***North Diversion Channel Outfall Site Inventory***

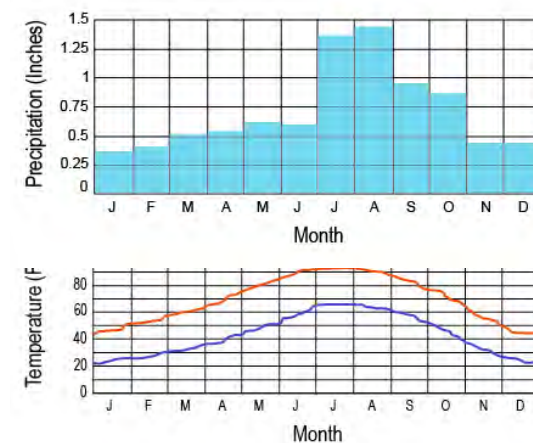


*North Diversion Channel watershed.*

The North Diversion Channel (NDC) serves 110 square miles of Albuquerque's urbanized watershed. This channel is one of the single largest components of Albuquerque's flood control system at nine miles long and capable of handling a 1% storm capacity of 44,000 cfs. All of this water dumps out into the receiving waters of the Rio Grande at the outfall area. The outfall area serves to slow this water down. Since the late 1960's when the outfall was constructed, the idea of giant single use infrastructure has been reconsidered, and it is time to retrofit this site so it will serve multiple functions, mainly improving stormwater quality.

## Land use and ownership

- Ownership: Operated by AMAFCA, land owned by Sandia Pueblo via a 2000' easement.
- Stakeholders: CABQ, AMAFCA, Sandia Pueblo.
- Current Land Use: Flood control outfall area and related operations.
- Adjacent Land Uses: Open space (Bosque), Sandia Pueblo (Bosque), and residential.
- Rights-of-Way: Flood control and irrigation go under the basin, utility lines cross over near the 4th st. bridge, rail road and vehicle bridges cross over the site, as well as a private drive on top of the North basin levee that serves a small land holding.



Albuquerque temperature and precipitation.

## Topography and Geology

- Contour map: GIS 1' contour from RGIS database.
- Proximity and elevation in relation to water source: outfall basin spillway 1500' to the East of the Rio Grande.
- Elevation change Over site: minimal; 2% or less, some places lower than the river 5' change over 2800'.

## Soils

- Permeability/Percolation rates: original core samples form ACOE, but decades of silt has probably changed the profile near surface, to be less well drained.

## Temperature and Rainfall:

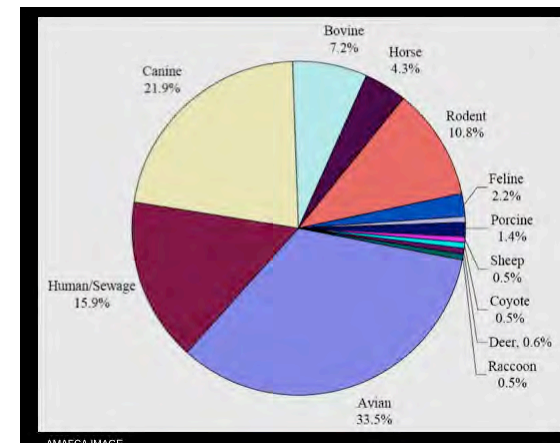
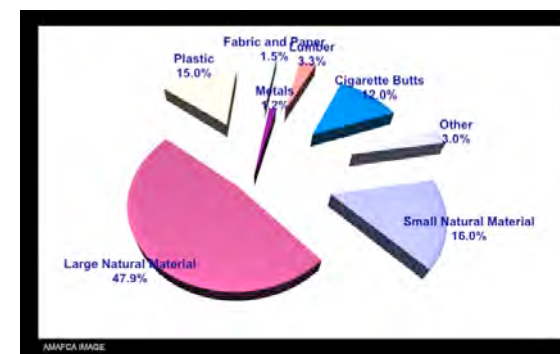
- Prevailing wind patterns: Spring – strong winds out of the SE, predominant from the west and Northwest.

## Nearby landscape features:

- Rio Grande and Bosque, View of the Sandias, Balloon park, neighborhoods to the south, elementary school, community center, and Sandia Pueblo.

## Length of growing season:

- 170 to 195 days



Pollutant constituents



Examples of plants on site.

## **BIOLOGY**

Due to its location within the Bosque, Sandia Pueblo land, and outer urban limits; the outfall area exhibits relatively rich flora and fauna species diversity. The outfall structure itself creates unique biomes from inundated marshland to rocky upland. These linear plant zones created from stormwater and the engineered structure provide habitat for a diverse array of species not normally seen together at a single site. Within a few hundred feet the plants shift from cattails and willows into prickly pear and *Datura* in linear patterns informed by stormwater levels along the site.

### **Presence of Plants observed on site:**

*Artemisia filifolia* Sand Sage  
*Gutierrezia sarothrae* Broom Snakeweed  
*Machaeranthera sp.* Purple Aster  
*Opuntia sp.* Prickly Pear  
*Psoralea scoparius* Broom Dalea  
*Salsola kali* Russian Thistle  
*Solanum elaeagnifolium* Silverleaf nightshade  
 Grass spp.  
 Annual Forbs  
*Achnatherum hymenoides* Indian Ricegrass  
*Bouteloua eriopoda* Black Grama  
*Bouteloua gracilis* Blue Grama  
*Erioneuron pulchellum* Fluffgrass  
*Kochia scoparia* Kochia  
*Sporobolus cryptandrus* Sand Dropseed  
*Tribulus terrestris* Goathead or Puncturevine  
*Atriplex canescens* Fourwing Saltbush  
*Datura meteloides* Jimsonweed  
*Dimorphocarpa wislizenii* Spectacle Pod  
*Hilaria sp.* Galleta grass  
*Phacelia integrifolia* Scorpion Weed  
*Rumex hymenosepalus* Curly Dock  
*Sphaeralcea angustifolia* Globemallow  
*Populus deltoides ssp. wislizeni* Rio Grande Cottonwood  
*Salix exigua* Coyote willow

### ***Presence of Animals observed:***

Birds of many types including a Bald Eagle, rabbits, and signs of beaver, raccoon and porcupine, with many additional species likely to be found on site.

- Threatened or Endangered Species: Silvery Minnow, and SW Willow Flycatcher.

### ***Cultural and Historic Significance:***

Significant and long history of inhabitation by native peoples, and Spanish presence, although the exact location of habitation is difficult due to the previous flooding nature of the Rio Grande before the levees were built.

### ***Hydrology***

- Groundwater depth: very shallow
- Inflows: records online at [http://waterdata.usgs.gov/nwis/uv?cb\\_00060=on&cb\\_00065=on&cb\\_00045=on&format=gif\\_default&period=3&site\\_no=08329900](http://waterdata.usgs.gov/nwis/uv?cb_00060=on&cb_00065=on&cb_00045=on&format=gif_default&period=3&site_no=08329900)
- Outflows: during storm events
- Receiving Waters: Rio Grande.

### ***Design***

- Engineering by Army Core of Engineers during the late 1960's, now run by AMAFCA.

### ***Data recording***

- Pollutant levels: Monitored by AMAFCA, during events some levels are elevated and of concern such as bacteria and BOD, Sandia reservation initiates their own testing and has increased standards.
- Pollutant constituent of the most concern are bacterial from fecal sources, hydrocarbon pollutants associated with the vehicle as well as a wide range of 'floatables' ranging in size and source.



*Some of the many birds at the site.*

4TH STREET

NDC FLOODWAY

BALLON FIESTA  
PARK

I-25 & TRAMWAY  
PARK



North Diversion Channel outfall location.

## ***Existing system component analysis***

Analyzing the existing components of the outfall area will, reveal opportunities for improvements proposed in the design, the following describing traces the current journey of the stormwater through the site's components. An aerial view of the outfall makes it appear like the long section of a motorcycle muffler serving to quiet or slow down the accelerated flows from the NDC. The journey that the stormwater takes moves from highly engineered conveyance structures directly into the river. Re-creating the stormwater journey to one that moves through a progression of increasingly natural ecosystems before entering the nearly natural system of the Rio Grande. The main overriding concept of this project is to create a series of progressively naturalistic pollutant removal systems to clean Albuquerque's storm water and help to meet EPA regulations.

Just prior to the storm water entering the outfall area the North Diversion Channel shape shifts from a trapezoid shape, into a box shape and begins to make a turn to the west, back towards the river. After making the turn the water passes under Edith blvd., and the concrete channel begins to gradually flare out.

Next the water passes under a railroad bridge before entering a low bowl-shaped area referred to as the 'Bathtub'. The 'Bathtub' serves to shift where the hydraulic jump happens during storm flows in order to avoid water overtopping and compromising the rail bridge. Currently AMAFCA is engaged in a project that serves to drain the 'bathtub', by pumping the water into an adjacent irrigation ditch after going through a stormwater quality feature. On average, between 2-5 cfs of very clean 'nuisance flow' water is transported down the NDC from various sources such as cooler condensate, and ends up into the outfall area. One component of this project proposal is to reuse this source of clean water for irrigation. This daily flow is a perfect source of water to establish planting strips used for phytoremediation, the establishment of a landscape buffer plants between habitat and circulation zones, and could even used to help Bosque restoration plantings.



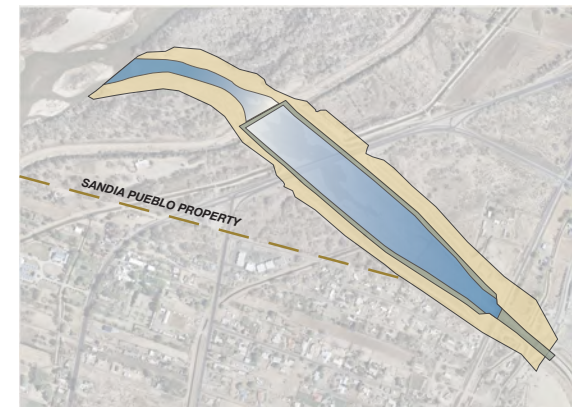
North Diversion Channel outfall component locations.

As the water leaves the 'Bathtub' it passes through three alternating lines of 'energy dispersing blocks', before entering the outfall basin bottom. Here, the outfall area begins to flare out to a width of 200' and the water moves from concrete surfaces to a natural soil bottom, with sides made from engineered soil, armored with large lava rock rip-rap up to 36" in diameter.

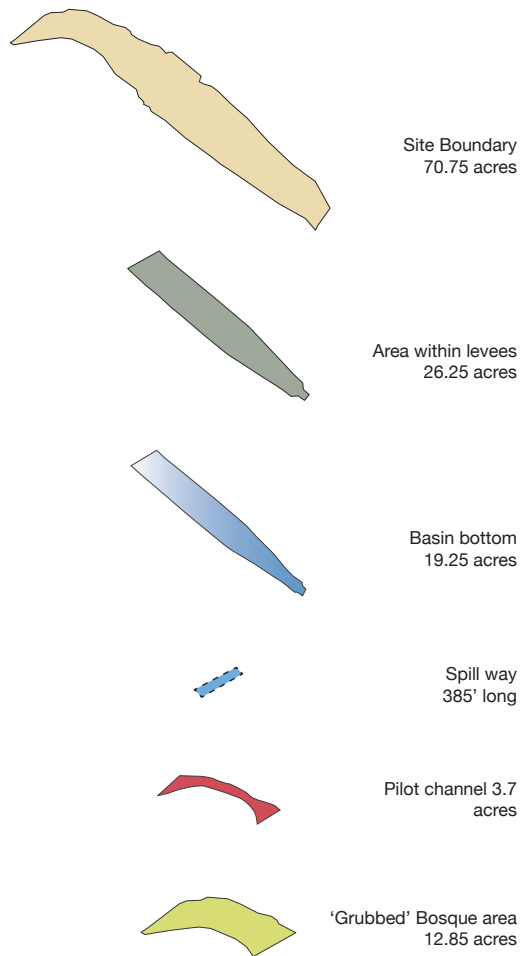
Next the stormwater moves over the 'sandpaper' area which serves to slow down the speed of the incoming water as it passes over the basin bottom that is covered with large rip-rap rock. Because this area cannot be maintained and scraped out of debris and sediment, some vegetation, such as Coyote Willows have been permanently established. This vegetation now serves several unintended purposes such as continuing to dissipate the energy of the stormwater, provide habitat, and act as a screens to catch litter and debris. Within this area, micro-channels and small islands have formed creating more naturalistic landforms, such as micro-pools that create waterfowl habitat, after storm discharges have subsided. Because this area is not dredged, it seems like a good area to establish larger permanent vegetation such as Valley Cottonwoods. Larger trees would serve to remediate pollutants, create habitat, shade water, create a buffer for site users, and establish seed banks. This pattern would be a good place to begin the new progressively naturalistic stormwater journey. In its current existence, this pattern unfortunately ends, and moves into areas that are dredged out on a yearly basis removing any permanent vegetation, habitat, and ability to remove pollutants.

At this point in the system, the stormwater is now on an easement within Sandia Pueblo property. Throughout the 'sandpaper' area the basin continues to flare out to its full width of 500' from levee top to levee top.

The stormwater is now within the main portion of the outfall area basin bottom. This area is about 2,000 feet long and 415 feet wide at the bottom, with levee sides 25 feet tall. Although the outfall area is designed for a maximum capacity of 44,000 cfs the most ever recorded is 17,000 cfs. The size of the outfall area is large, with the entire



*North Diversion Channel outfall land easement..*



Existing site component sizes.

boundary covering an area more than 75 acres. The entire area of the basin bottom is scraped out at least once a year removing the accumulated sediment and debris. Although many opportunistic plant and animal species begin to inhabit this area by late summer, they are not allowed to persist, thus minimizing many positive impacts. The aerial image in figure shows how the site is quickly effected by pioneering vegetation. The proposed designs will take into consideration the continual ease of maintenance that must take place on this site. Creating vegetation that will help to remove pollutants, as well as tolerate a maintenance regime will be crucial to the functionality and success of the design.

A series of service roads flank the site and are served by access points at 4th st. And Edith Blvd. These roads could be re-appropriated for the proposed bike path extension and increased pedestrian circulation within the site, increasing access and awareness of the site and its system.

The main area of the basin bottom is extremely flat with a drop of only 5' over 2,800' from the NDC outlet to the pilot channel. This lack of hydraulic head or pressure limits the possibilities of commonly used BMP's for debris removal.

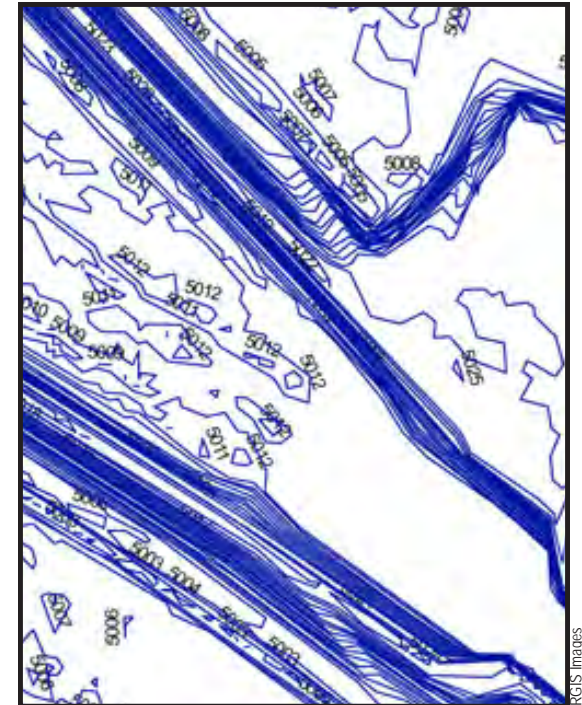
Splitting the outfall area nearly in two, is the 4th st. Bridge. This bridge accommodates four lanes of fast moving traffic with little or no shoulder for cyclists and pedestrians. This bridge does however create opportunities for viewing the site allowing people to see on a daily basis, a component of sustainable infrastructure, and Increasing awareness of Albuquerque's stormwater systems. Redesigning the bridge guard rail is one way that the proposed design will accomplish this is. Reworking the bridge design will allow for better viewing of the basin from a car, and create opportunities to present public art. Although the bridge is quite large, does not feel particularly creepy or threatening underneath. The bridge creates an enjoyable microclimate, different plant life, and good surfaces for swallows and bats to nest. Because of the high traffic level on this bridge it will be important to create pedestrian and bicycle trails underneath it.

Before the stormwater leaves the basin it must pass through a key component of the system called the ‘equipment’ crossing which serves as a spillway separating storm water and Rio Grande water as well as, providing a crossing point for equipment. This component is basically a dirt road with a low, gabion style wall on the downstream side to prevent erosion. The spillway or ‘equipment crossing’ is only about one foot above the bottom of the basin on the upstream side and about two feet above the water level of the pilot channel. During storm events water overtops the spillway, thus eroding the crossing road, allowing debris to move over it directly to the river, doing little to slow the storm water, or to retain it for a long enough period to allow for sediment dropout.

Under the equipment crossing are three 8” culverts fitted with flapper valves that serve to drain the outfall basin into the pilot channel. These culverts seem problematic for several reasons: The height of the spillway only allows for a very shallow amount of water to be retained in the basin, the placement of the culverts is at such a grade that they allow river water to flow backwards up into the basin itself. Additionally one of the culverts is completely clogged with mud, preventing any flow. The flapper valves meant to discourage fish seem to be stuck open and not functioning. Finally the pipe seems to be considerably undersized. The spillway is crucial in controlling flows and water levels within the basin thus pollutant removal effectiveness.

The spillway will also be a critical component of the proposed design for several reasons: it serves to manipulate the water level and flow rate within the basin, with the purpose of manipulating these levels in order to increase effectiveness of pollutant removal through phytoremediation, screen out, and encourage drop-out of debris, create wildlife habitat, and aide in Bosque restoration. The design for the spillway will also serve as a manifold to distribute storm water, out into the Bosque, in a dispersed fashion that helps to mimic natural over-bank and rivulet flooding patterns, aiding in nearby restoration efforts.

The final components in the storm water’s journey to the river, is the ‘Pilot Channel’ and surrounding Bosque area. This dug channel serves to move stormwater from the



RCIS Images



Site topography examples, showing very level grade.



## **Plant zones**



**Marshland - saturated**



**Streambank - Intermittent**



**Remnant Bosque**

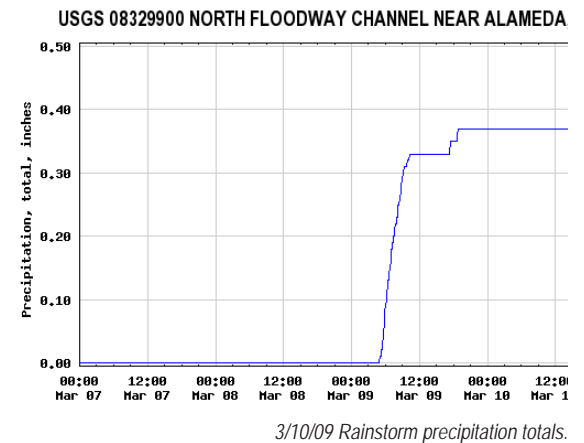


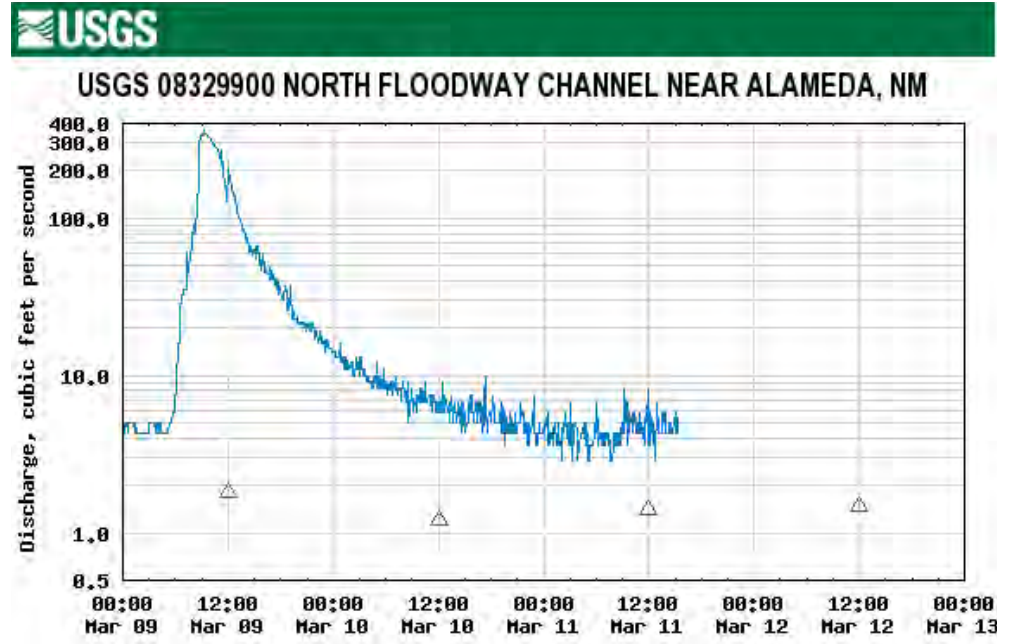
**Dry - Upland**

*Plant zones created by the outfall area.*

basin into the river. The channel is about 110' wide and 1,400' long, and up to eight feet deep, and is the final part of the big U-turn that Albuquerque's storm water takes moving North then back South into the Rio Grande. The beginning of the channel is only one foot higher than its end at the Rio Grande. Flanking the pilot channel are 200' sections of the Bosque that have been 'grubbed' or cleared of vegetation besides grasses and forbes. Both the pilot channel and the cleared Bosque area feel ecologically dead, lacking diversity and complexity. The sides of the channel are between 1-3 feet above the top of the water level, with vertical cut sides. Where the channel curves to meet the river an sand bar often forms a plug cutting off circulation within the pilot channel. This stagnant water is suspected of causing fish kills in the Rio Grande due to low dissolved oxygen levels. This component of the system sits within an amazing strip of habitat at the edge of urbanization. The Pueblo of Sandia, whose land the Pilot channel sits within has engaged in extensive restoration efforts within sections of the Bosque neighboring the land easement. The proposed design seeks to use the resource of stormwater to create marshlands, and aide in native plant restoration efforts, rather than clearing out native vegetation. The stormwater will be distributed throughout sections of the Bosque, creating a complex series of marshland, channels, islands, pools, and braided rivulets.

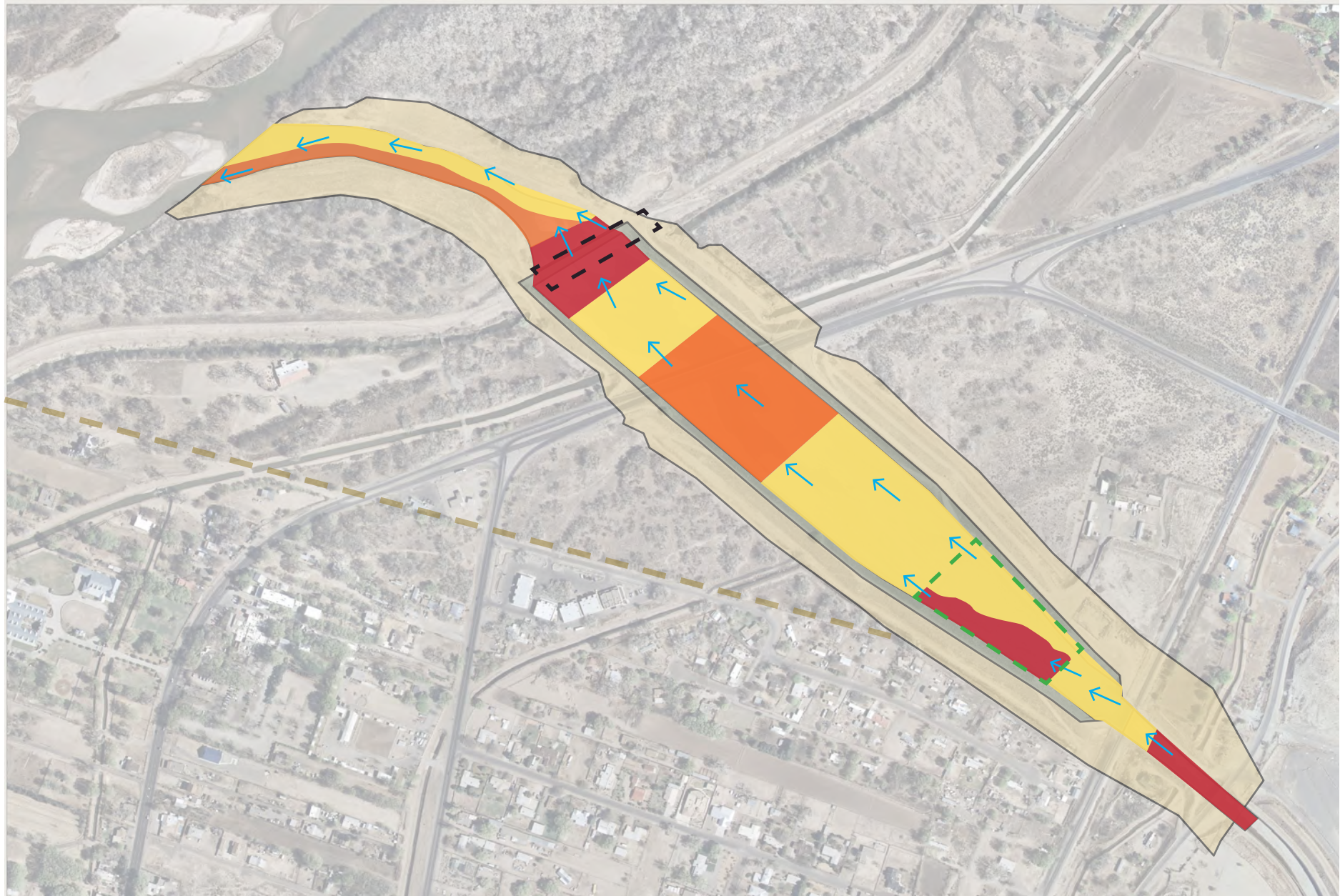
On 3/10/09 a rainstorm finally hit the Albuquerque area after three months of drought. This presented a great opportunity to see firsthand the site in action. Although small, compared to monsoon events, a surprising amount of water moved through the outfall area on this day. A USGS monitoring station just upstream from the site, details the rainfall and discharge of the NDC into the outfall area. Within 3 hours of the storm starting, peak flows occurred, showing the force and suddenness of discharge at this site, and the importance of considering these patterns within the design. This storm had a peak discharge of nearly 400 cfs which seem like a lot, except when considering the record of 17,00 cfs. Within 36 hours of the event starting the discharge rates were back to normal flows. Basically a wall of fast-moving, extremely dirty, water is forced into the site and then leaves within a day. By observing floating debris during the storm, I was able to create a map of relative water movement speeds. This diagram shows that speeds are not consistent within the outfall area





3/10/09 Rainstorm discharge totals.





 **Slow**

 **Medium**

 **Fast**

 **Direction**

 **Spillway**

 **Rip-Rap Area**

3/10/09 Rainstorm relative water speeds.

and highlight the lack of control that even highly engineered structures have over the power of stormwater. The proposed design will allow for dynamism and the formation natural drainage patterns within the outfall area. The stormwater on this day was a nasty dark grey color, filled with trash and debris of all types, thus reinforcing the necessity of cleaning this source of pollutants before it enters the once magnificent Rio Grande.



*Un-dredged basin*

# Site Components

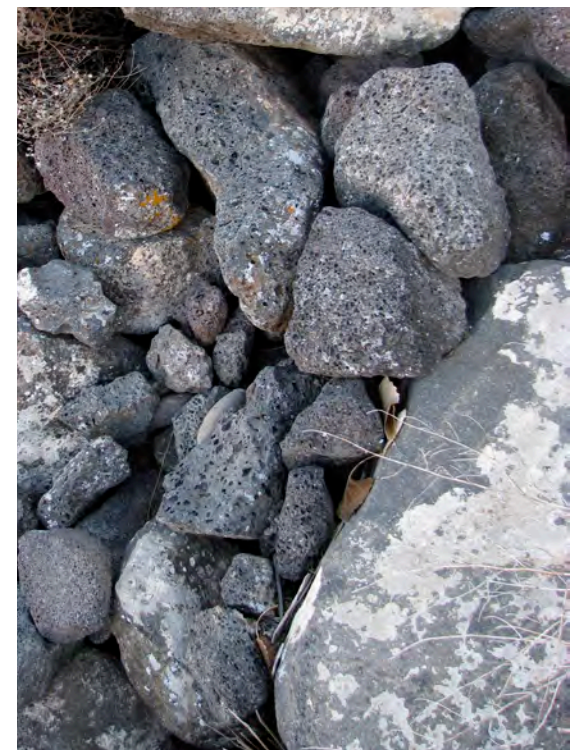
*North Diversion Channel*



# 'Bathtub' + Rail Road Bridge



## Levee Banks



## 'Rip-Rap' Zone



## Access Roads





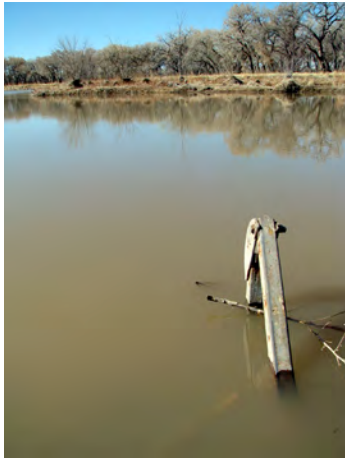
 **Access Gates**

 **Service Roads**

**4th st. Bridge**



**Spillway and 'Equipment Crossing'**



**Pilot Channel + 'Grubbed Area'**

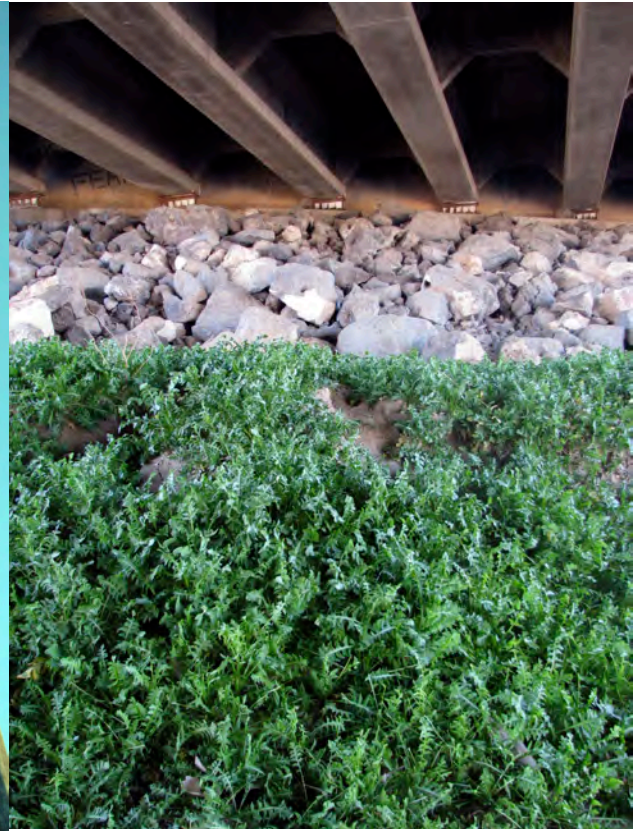


# Visual Analysis

## Patterns



*The site exhibits a multitude of existing patterns such as lines, shapes, and landforms*



## Colors



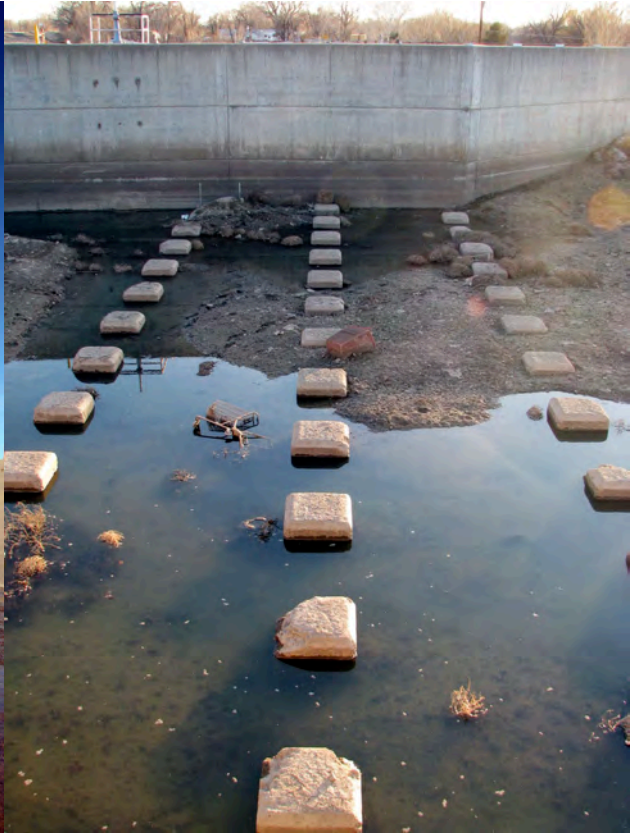
*Numerous colors exists at the site man-made and natural that are effected by seasonal changes and light*



**Forms**



*Forms existing at the site are large and dramatic.*



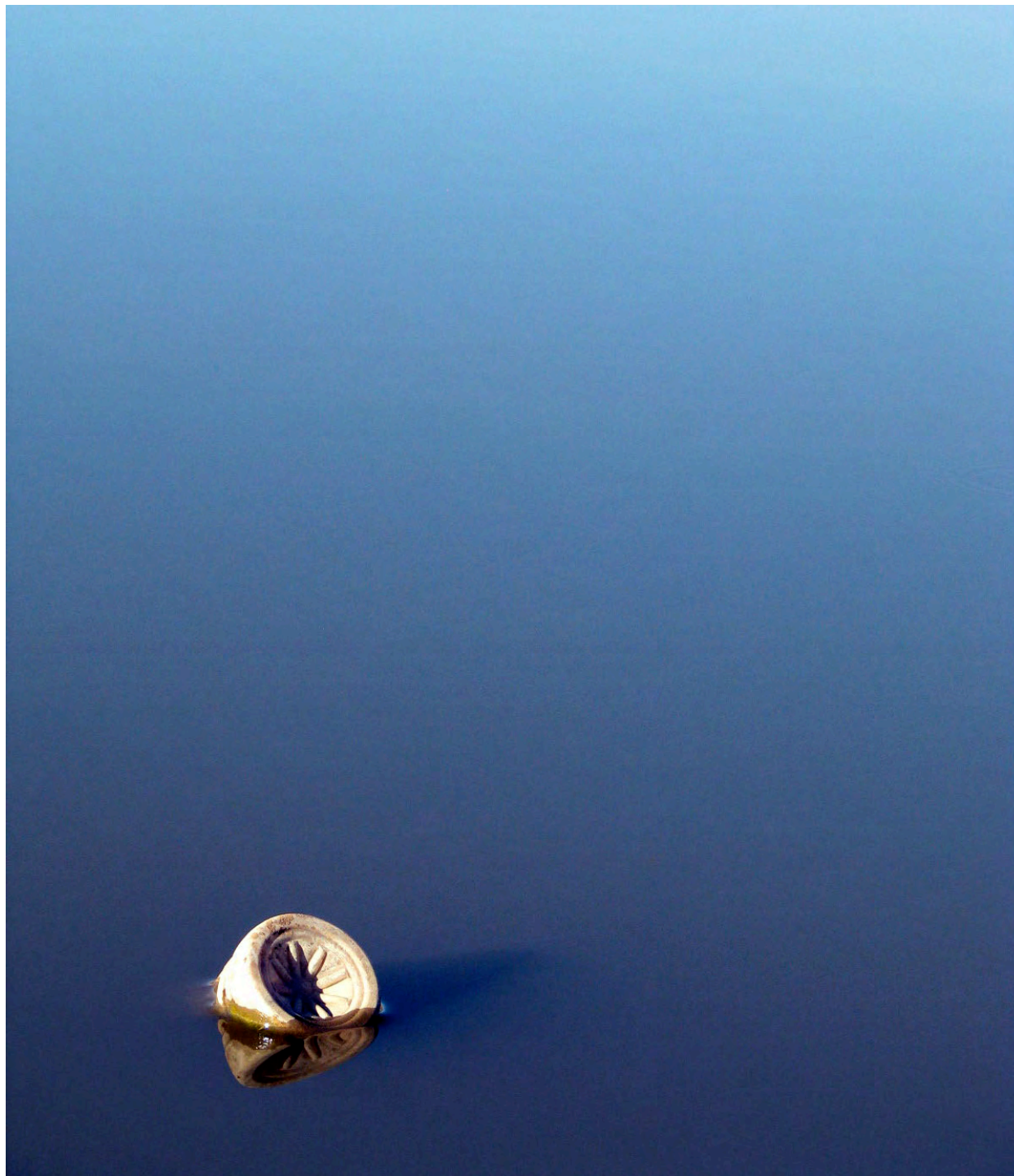
## Textures



*Man-made and natural textures transition from smooth to rough and are both permanent and ephemeral*



## Light



*The quality of light changes the colors of materials at the site, creating new patterns and water reflections transpose the sky on to the ground plane*



**Materials**



*Man-made and natural materials are effected by many dynamic processes.*



**Natural Processes**



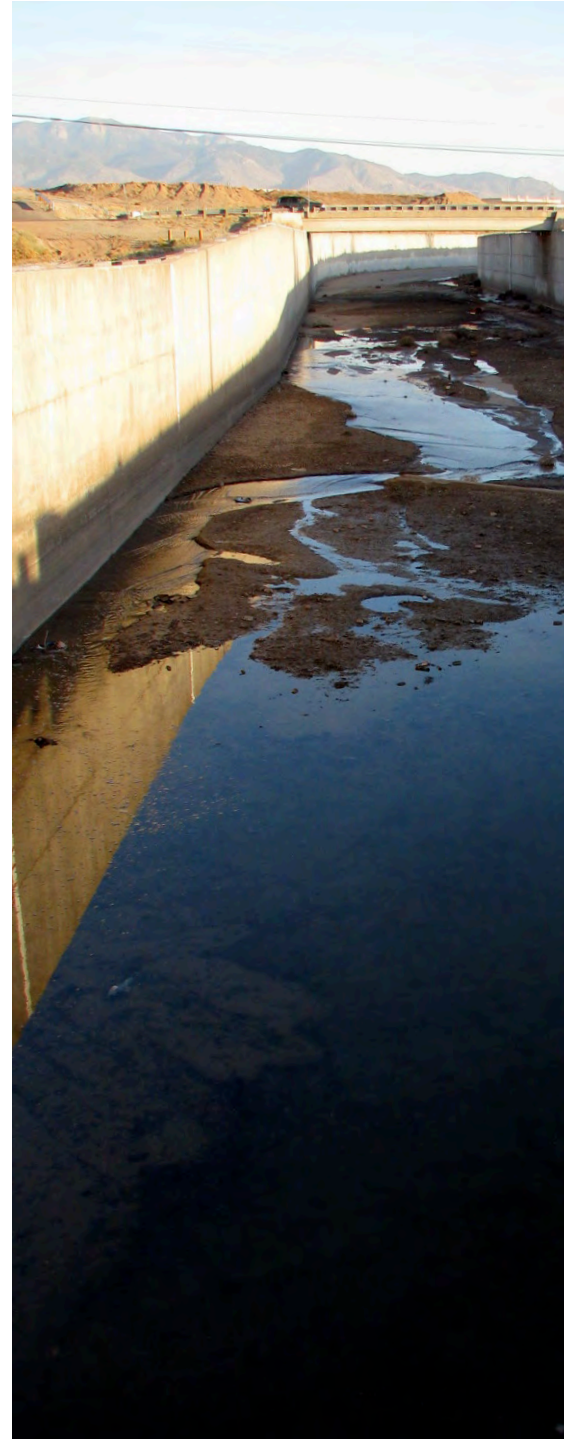
*Natural processes dominate the site despite the attempts of control.*



**Views**



*The site features wonderful views within, and out of the site.*



## ***Cultural Context***

In addition to creating a visual catalog of site features which will begin to inform the design, other important considerations have informed my thought process that will be synthesized and integrated into the proposed design components. The effects of water directs the largest set of influences that will be synthesized and used to inform design moves.

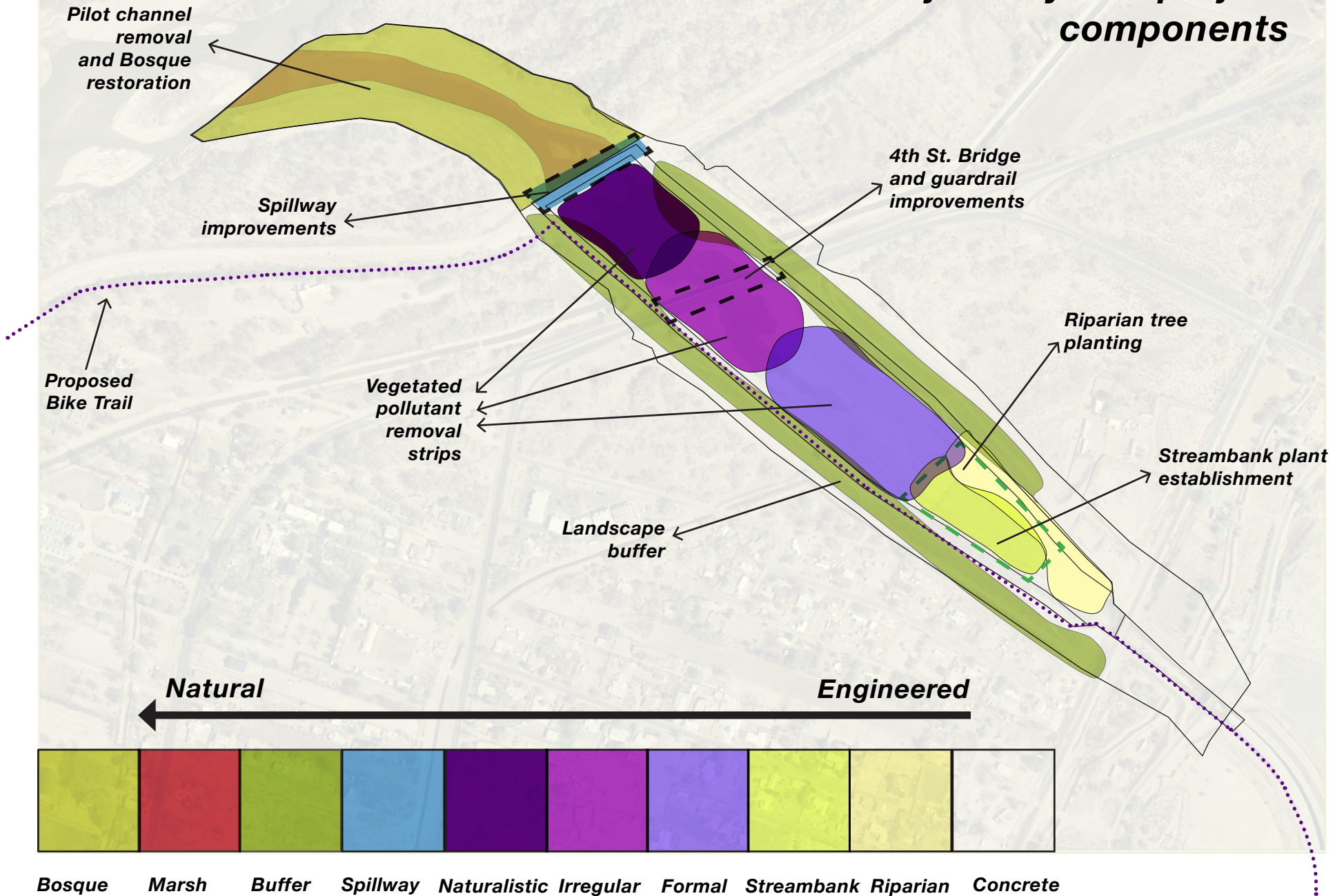
The manipulation of Albuquerque's watershed funneled to the single point of the outfall area, is representative of the alteration of dynamic systems necessary to make way for development. The NDC system is at first difficult to understand, because the stormwater appears to run up-hill and North. Water that falls at the Southern edge of the watershed takes a 20 mile detour to end up where it would have originally dumped into the Rio Grand.

In the desert, a little water goes a long way, having dramatic effects on plant and animal life by increasing diversity and chances of survival. Water in the Southwest is appreciated in a way that it cannot be in other less arid climates. Light and views are effected by water and its reflections. Water tends to stir feelings of humans, evoking memories, and inviting interaction.

Water related dynamic processes can be recorded through the memory of materials in many ways, such as: staining, vegetation change, soil moisture, debris captured by plants or structures (remnants) and, its movement and directional flow patterns. Materials can also display the strength of storm flows and their past levels. Materials on site will become gauges or markers thus serving as memory from past flood events.

Present on site, are infrastructure components that have all contributed to Albuquerque's development. These systems that have allowed for progress are the Rail Road, Drainage + irrigation ditches, flood levees, vehicle bridges, and power + telephone cables. Although much of this infrastructure could be more sustainable, Albuquerque could not be the city that it is today with out them. The large landscape-scale lines and shapes that these pieces of infrastructure create are intriguing and will inform the proposed designs.

# Water journey and project components



Pollutant Removal Strip Forms

Progression of treatments allowing the stormwater's journey to transition to the relative natural receiving waters of the Rio Grande, and where components exist.

## ***Project Components***

### ***Pollutant Removal***

The primary goal of this project is to remove pollutants and debris before Albuquerque's urban stormwater enters the receiving waters of the Rio Grande. The strategies outlined below; incorporating various strategies to do this work.

#### ***Vegetative strips***

- within the basin; to screen debris and extract pollutants through wet soil. Some important considerations for these strips will be:
- Establishment and irrigation
- Maintenance and relationship to growth , storm season, and need to remove debris
- Forms will be based on existing geometry of highway and rail tracks

#### ***Phytoremediation***

- several native species will be used to remove chemical pollutants in the stormwater mostly through the process of phyto-extraction. Manipulating water level and duration will be crucial for the effectiveness of this process, and it will be important to consider how the harvested material is managed in order to create a closed loop or minimal waste generating system.

### ***Spillway and “Equipment crossing” improvements***

- This component is key to several functions of the design and becomes a means of manipulating water level, speed, and duration within basin to improve storm water quality and allow for phytoremediation to occur. This component will also serve as a distribution manifold that servers to distribute water throughout the Bosque area which will aide in restoration, marshland, and habitat creation.

### ***Pilot channel removal***

- Removing the pilot channel will serve several purposes such as, eliminating the problem of low dissolved oxygen water, and helping to restore the damaged Bosque area. The design instead creating a series of micro-pools, marshlands, and deltas, that will serve to aide in Bosque restoration, and pollutant removal

effectiveness. This portion of the site will also serve as the final piece of progression from simple to complex, recreating a nearly natural delta based system, moving from a single outflow point, to a multitude of rivulets that enter the river in a more natural way.

### ***Daily flow re-usage (nuisance flow)***

- A substantial amount of water, from coolant condensate and other sources, moves into the site on a daily basis. This ‘nuisance’ flow will be re-used for beneficial means to increase the performance of several of the project components including:
- irrigation to establish plantings in pollutant removal strips and buffer area.
- to create marshland and waterfowl habitat.
- establish plants for restoration at “grubbed” area bordering and within old pilot channel.

### ***Landscape buffer***

- Creating a planted buffer will serve several important functions such as:
- Creating a sense of intentionality at the site that increases awareness of the design and function of the system, and creates areas in which dynamic functioning systems are allowed to exist and change over time.
- Separate points of human access and wildlife habitat.
- Larger trees within the buffer will serve to shade water, people, and animals.
- Create a screen that promotes wildlife and human circulation.

### ***Marshland and waterfowl habitat***

- Creating multipurpose marshlands will be located mostly within the former pilot channel based on natural Bosque wetland models which will serve several purposes for this site.
- Allow for sedimentation and adhesion of pollutants.
- Improve human enjoyment and education opportunities.
- help to create progression from man-made to natural before the stormwater enters the Rio Grande.

### ***Connection of NDC and Bosque trails to site***

- Currently the NDC trail follows the current stormwater path through its altered watershed, the proposed bike path extension will be connected to the Bosque trail via the outfall area; so that the trail follows the entire watershed path to the river, completing a big U-turn along with the stormwater, adding about 4.25 miles to the existing trails. Access and connections are problematic for several existing AMAFCA sites despite their beauty and habitat value; extending the bike trail and creating parking areas to access the site will serve several purposes.
- Increase access, user level, and interaction with system.
- Create loop out of Albuquerque's existing bike trails.
- Create a destination and amenities for trail users.
- Increasing awareness of the system and the site will add to the understanding and possibilities for sustainable infrastructure as a part of our daily lives.

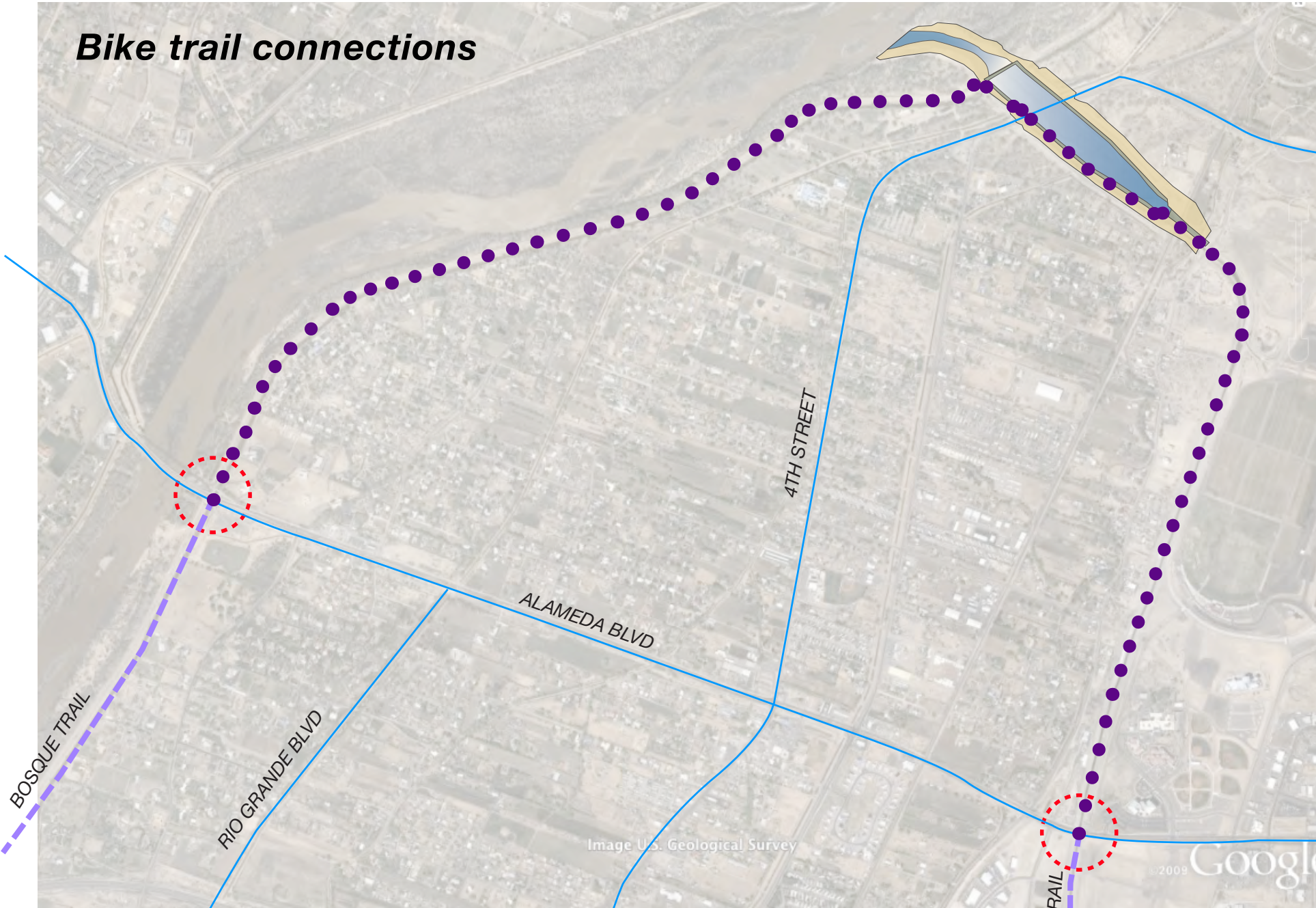
### ***4th St. Bridge guardrail***

- The current bridge design prohibits viewing of the basin bottom from a car thus decreasing awareness of the system. Crossing over the bridge on foot or bike is currently sketchy at best, therefore increasing safety will improve access and use by the community. The proposed bridge and traffic re-design will:
  - Increase visibility for looking down at basin and subsequent designs
  - Create 'bump-outs' for viewing the site, increase median width for safety, and create spaces for interpretive art displays along the bridge edges.

### ***Conclusions***

The project hopes to create an engaging open space that accommodates recreation, increases public awareness of natural systems, infrastructure, and that is connected to the existing trail systems, in place of the single-function, restricted access, settlement area that currently exists. This site is important in that it represents the last chance to clean contaminated stormwater before entering the receiving waters of the Rio Grande. This site is in a beautiful location within the Bosque, and features unimpaired views of the Sandias. Unlike other stormwater facilities in Albuquerque, this site has high visibility, due to several roads that cross over it, thus providing opportunities for exposure to sustainable infrastructure and thus helping to increasing awareness of its importance.

# Bike trail connections

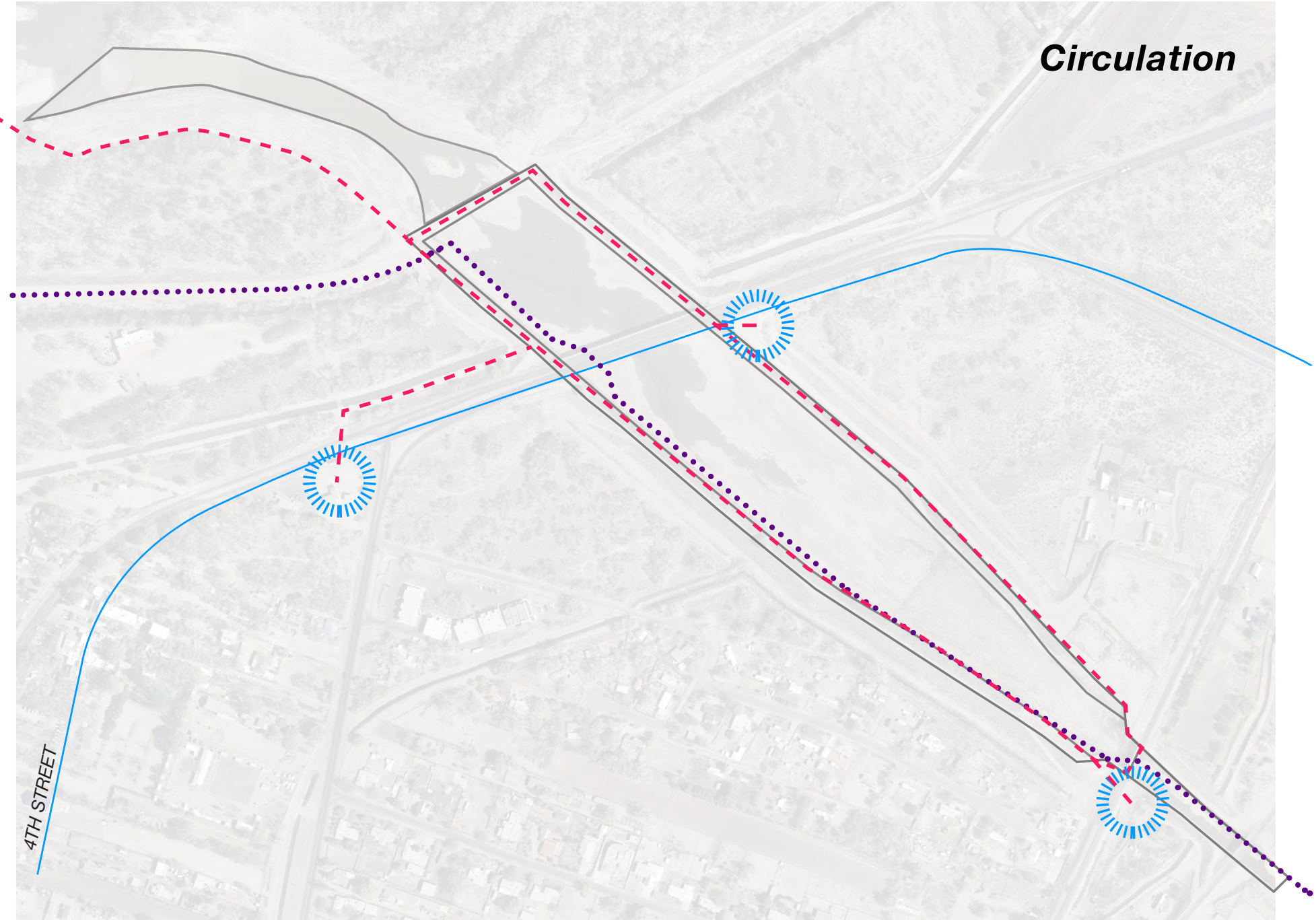


 **New Connection points**

 **Existing Trail**

 **Proposed Bike Trail**

# Circulation



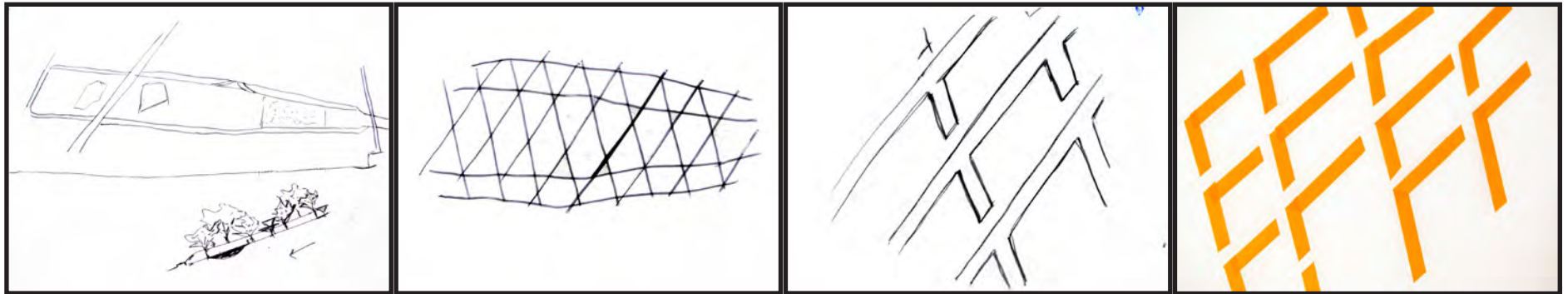
**Parking Areas**

**Proposed Walking Trail**



**Proposed Bike Trail**

# *Vegetated pollutant removal strips pattern development*





*Collage depicting what a portion of the pollutant removal strips and tree plantings might look like.*



*Collage depicting pollutant removal strips within the basin.*



*The basis for plant choice will be based on native models that tolerate the type of maintenance regime required of the site .*





*Collage depicting the importance of creating beds that allow for the basin to be dredged out every year.*



*Unlike the existing pilot channel structure this image shows what a more natural delta drainage system might look like.*



## DESIGN PROPOSAL

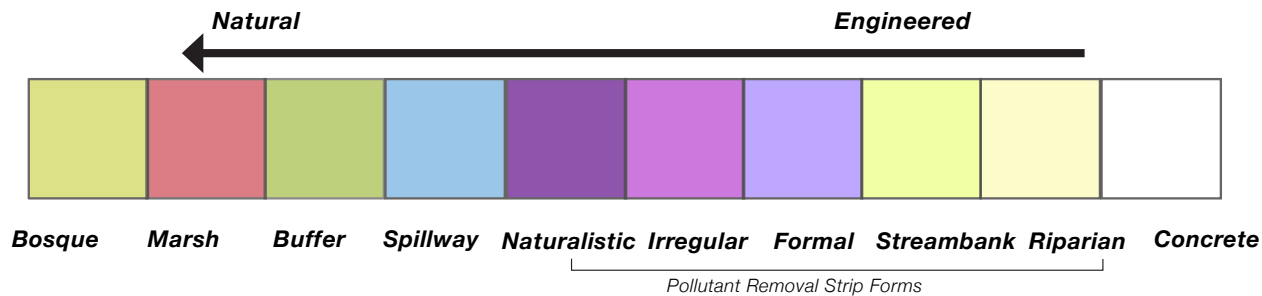


The following design proposal is intended to illustrate and test the findings and recommendations outlined above. This site is important in that it represents the last chance we have to clean contaminated stormwater before it enters the receiving waters of the Rio Grande.

The conceptual design approach for this proposal is to use icons and patterns of the consumerist landscape to create awareness and improve the quality of Albuquerque's storm water. The design uses this approach to create an engaging open space that filters Albuquerque's urban stormwater and increases awareness of natural and infrastructure systems by retrofitting the single-function outfall area that currently exists.

**Several general systems are used in the proposal as a means of meeting the goals of the project these systems include:**

- *Creating a vegetated filter within the outfall basin*
- *Diverting a portion of the discharge for phytoremediation*
- *Naturalizing the pilot channel and restoring the neighboring Bosque areas*
- *Creating habitat*
- *Increasing access and site amenities*
- *Increasing the public's awareness of the system and their role in contributing to the pollution.*



**Research**  
 +  
**Site Analysis**  
 +  
**Goals**  
 +  
**Concept**  
 +  
**System Approach**  
 =  
**Design Proposal**

## ***Design Components***

- *Bike path extension interventions*
- *Filtration Bars*
- *Flanking treatment zones*
- *Shade structures*
- *'Trash' art intervention opportunities*
- *Neighborhood connection walkway*
- *Bridge improvements*
- *Phytoremediation fields*
- *Nuisance flow re-use*
- *Equipment crossing improvements*
- *Pilot channel naturalization*
- *Recirculation channel*
- *Bosque restoration*
- *Bosque walkway*
- *River lookouts*

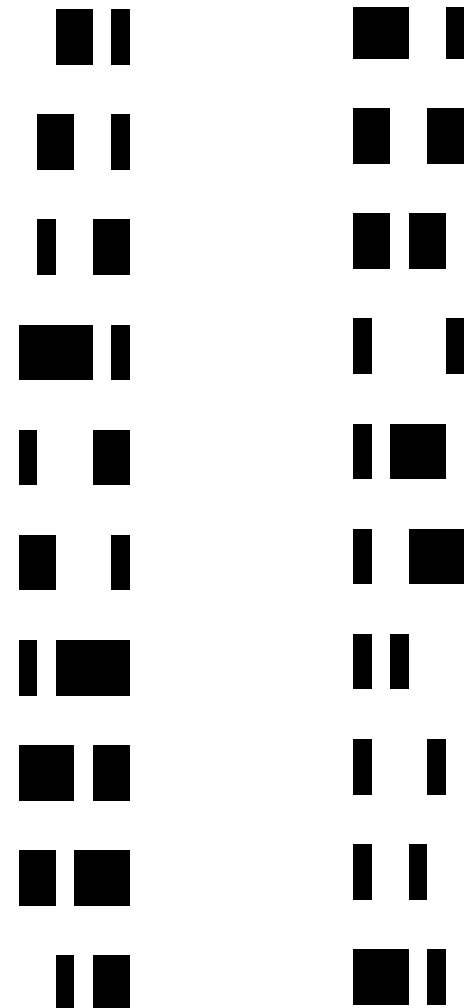
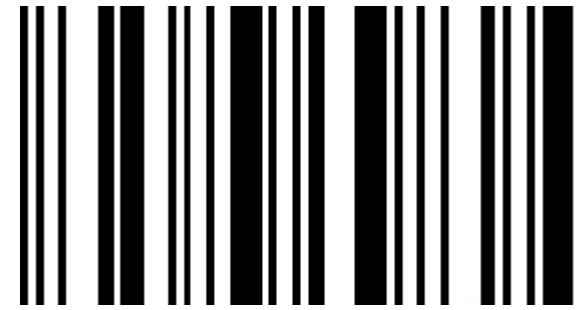
# Conceptual Approach

The General conceptual approach for this design proposal has been to use icons, patterns and materials of the consumerist landscape as a means of tying together issues, goals and objectives into a site design whose primary function is to remove stormwater pollutants before they enter the Rio Grande.

Stormwater pollution is a result of our societies's extreme hunger for consumption and development. The bar code is a prevalent yet little understood symbol within our consumerist landscape that has been re appropriated for use within this design proposal. This pattern influences many of the forms and design moves that appear with in the proposed plan for several reasons such as:

- The symbology and similarities of the bar code within the consumerist landscape and the flood control landscape.
- The hope that this pattern will create an awareness as well as server to function to remove pollutants.
- Create functionality that reveals an intentionality.

Several other material that have been selected for this design also help to reinforce these concepts such as shopping carts and highway guardrail material. Both of these materials are currently prevalent at the site and our contemporary landscape.



On-site material inspiration





Consumerist Landscape



Pattern Applied to Site



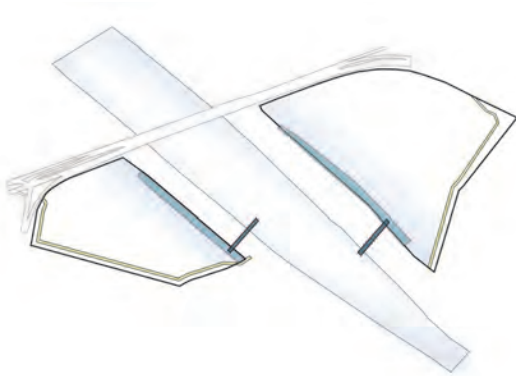
Slow
  Medium
  Fast
  Direction
  Spillway
  Rip-Rap Area



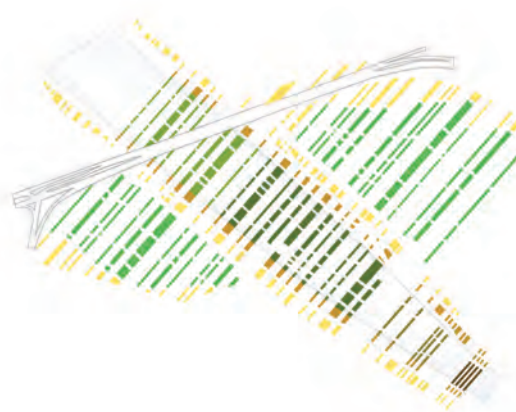
Marshland - Saturated
  Streambank - Intermittent
  Remnant Bosque
  Dry - Upland



Bar Variation and Spacing



Flanking treatment zone



Filter Bar pattern



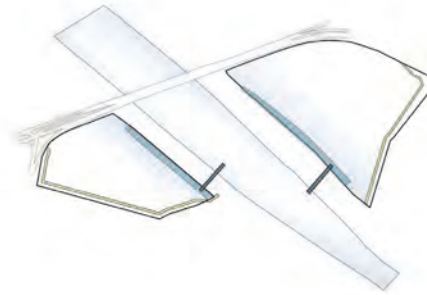
Willow filled shopping cart filtration bars

### *Vegetated pollutant filter bars*



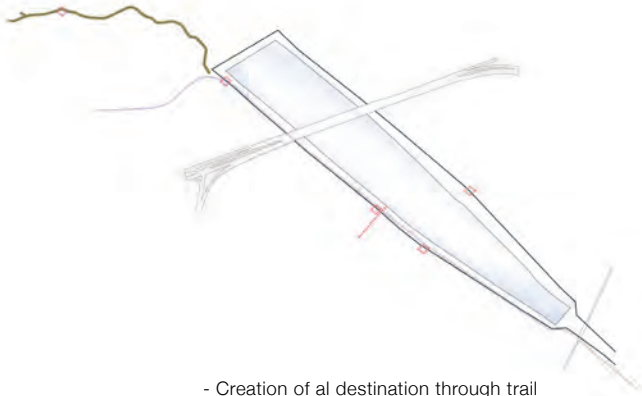
- Pattern based on iconic consumer pattern.
- Variety of materials and spacing based upon directing flow, stage of filtration, and visibility.

### *Flanking treatment zones*



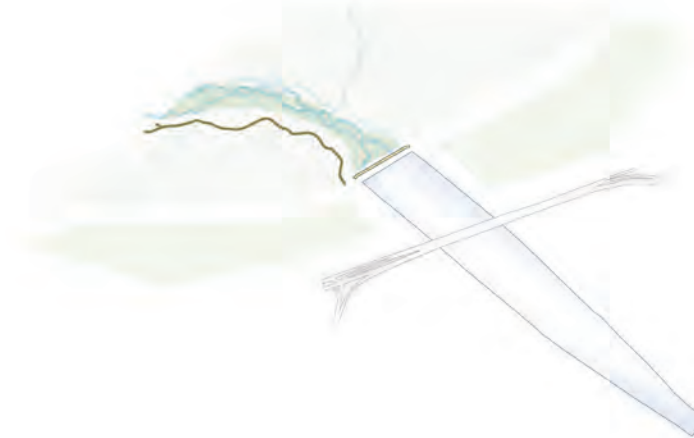
- Increased treatment capacity and limitation of constituent re-suspension.
- Infiltration and restoration of bosque and water table

### *Site amenities and Connections*

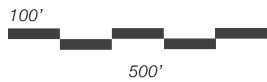
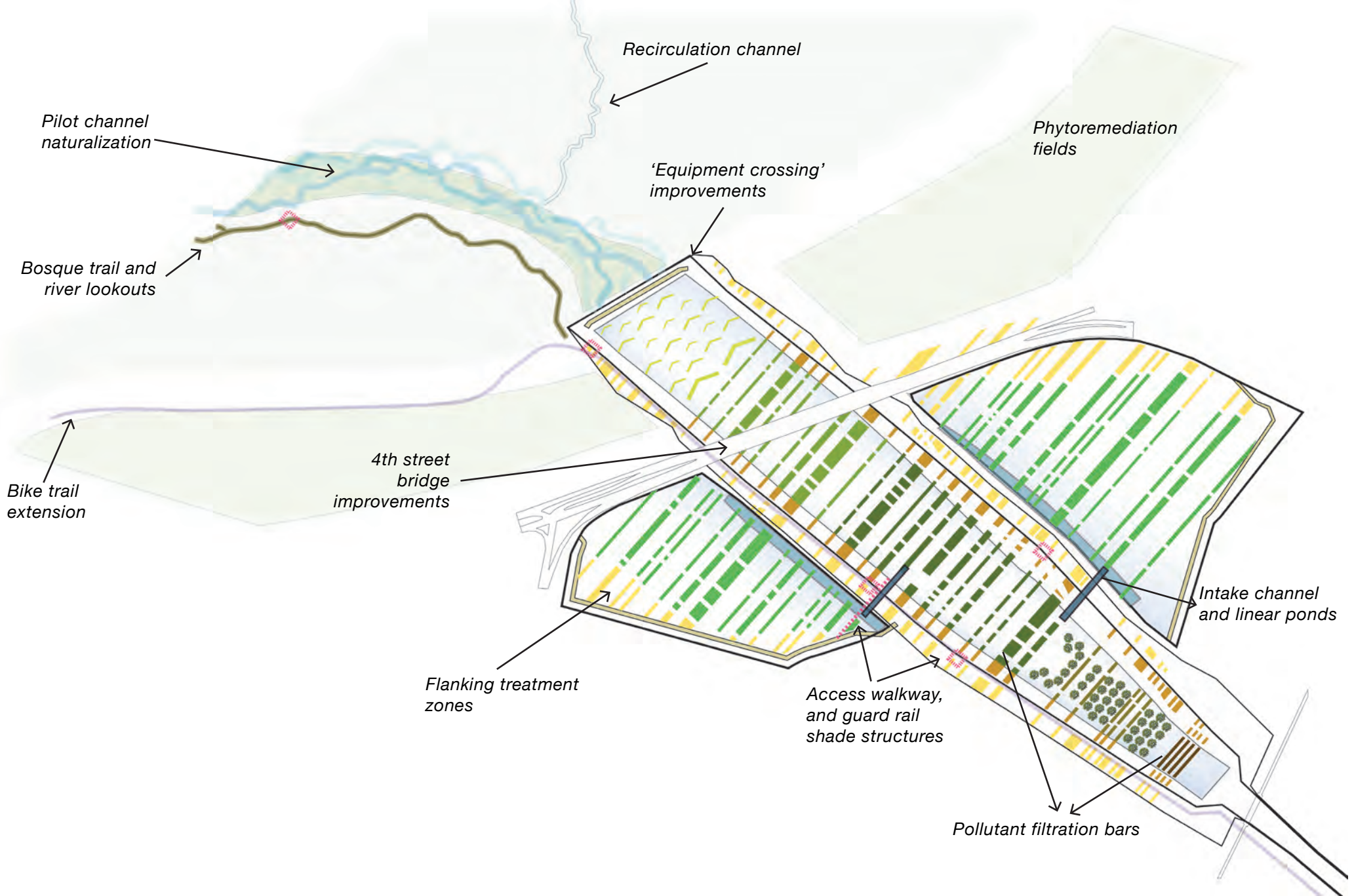


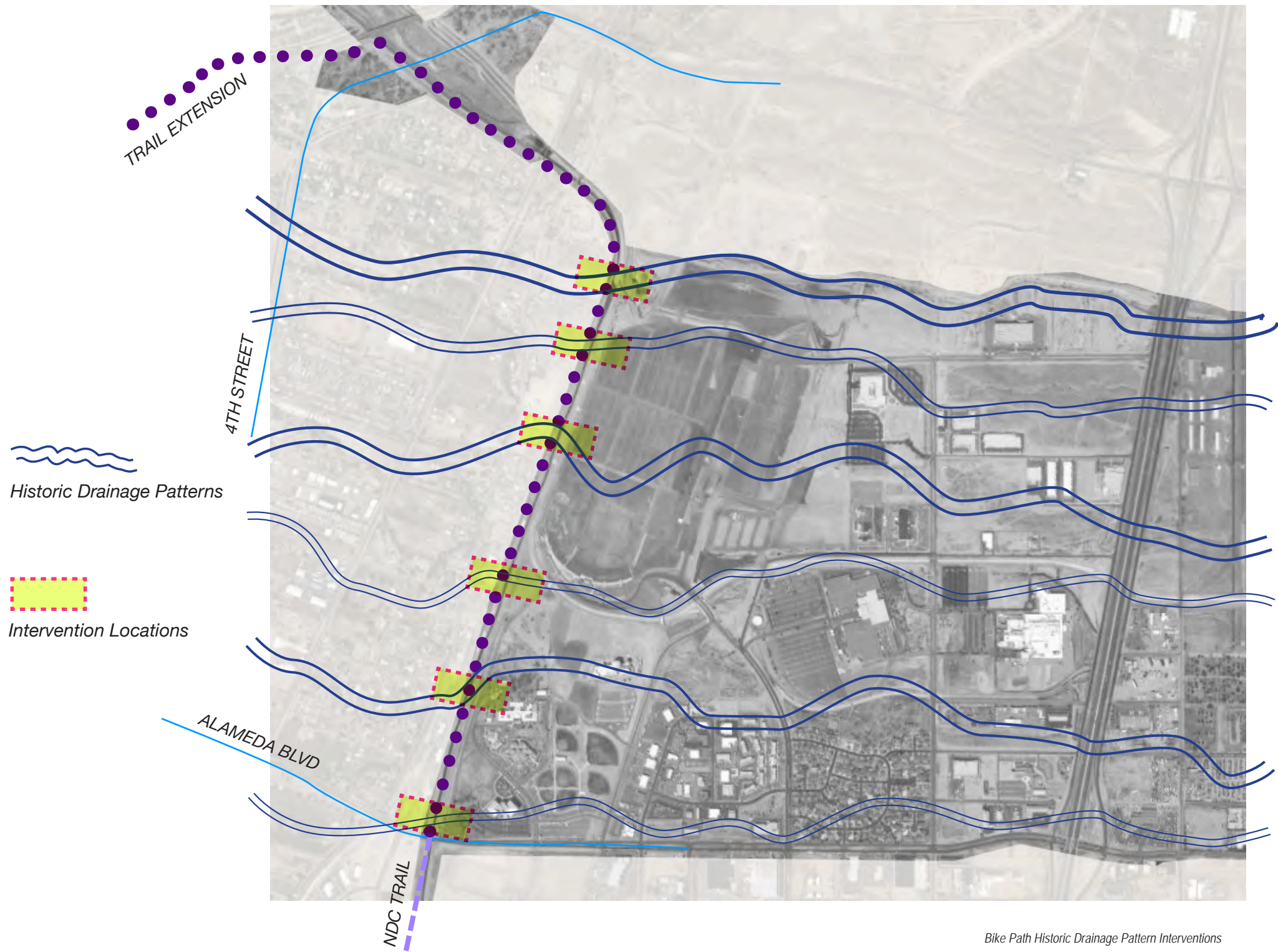
- Creation of al destination through trail connections, access, and site amenities.

### *Pilot channel naturalization*



- Pilot channel braiding and island creation
- Recirculation channel





*As stormwater makes its way north to Alameda Boulevard in the North Diversion Channel the proposed bike path extension and a series of interventions concerning historic drainage patterns begin. Intended to increase awareness of the flood control system, these interventions invoke memories of the once existing natural arroyos, and their landscape patterns as they made their way to the river. The arroyo planting and pavement markings, effect multiple senses to remind trail users of the extreme alteration of this natural system.*



The progression of materials and spacing that makes up the filter bars is determined by several factors. The main consideration has to do with maintenance requirements of the site which require deposited sediment to be removed on a yearly basis. Breaks within the bars serve to allow for loaders to maneuver within the basin and allow help to direct water. The vegetated bars that are within the basin, are contained by materials such as shopping carts and guard-railing to allow for the loader bucket to easily remove debris.

The entire site is in effect a large staged filter. The beginning stages of the filter allow for significant debris holding capacity as larger debris will drop out first, as well as allowing for more frequent mechanical removal. As the stormwater move through the site finer and finer pollutants are removed. With some constituents removed through the process of phyto-extraction. Several of the native plants that exist at the site will be used in the filter plantings, and also happen to be some of the top phytoremediation performers.

The native coyote Willow (*Salix Exuiga*) is the main plant material used within the basin bottom bars. This plant has evolved with the Beaver and has adapted to being cut at the base of the plant. The willow bars would be pruned on a yearly rotating schedule. The willow debris and floatable debris that they filter out during the season would be removed and composted within the flanking treatment zones in windrows.

The flanking treatment zones allow for a more complete treatment of a portion (about 20%) of the discharge. Through a series of processes such as sedimentation drop-out, infiltration, and phytoremediation, the stormwater is treated over a period of several days and does not allow for the re-suspension of pollutants which might occur within the basin upon subsequent storm flows.

The filter stage that is nearest the bridge is made of willow planted shopping carts, as a symbol of consumerism and product packaging that makes its way to the site. The shopping carts are re-appropriated to remove this packaging and debris that pollutes the Rio Grande as a result of consumption.

As the bars extend out from the basin they are planted with material that reflects the

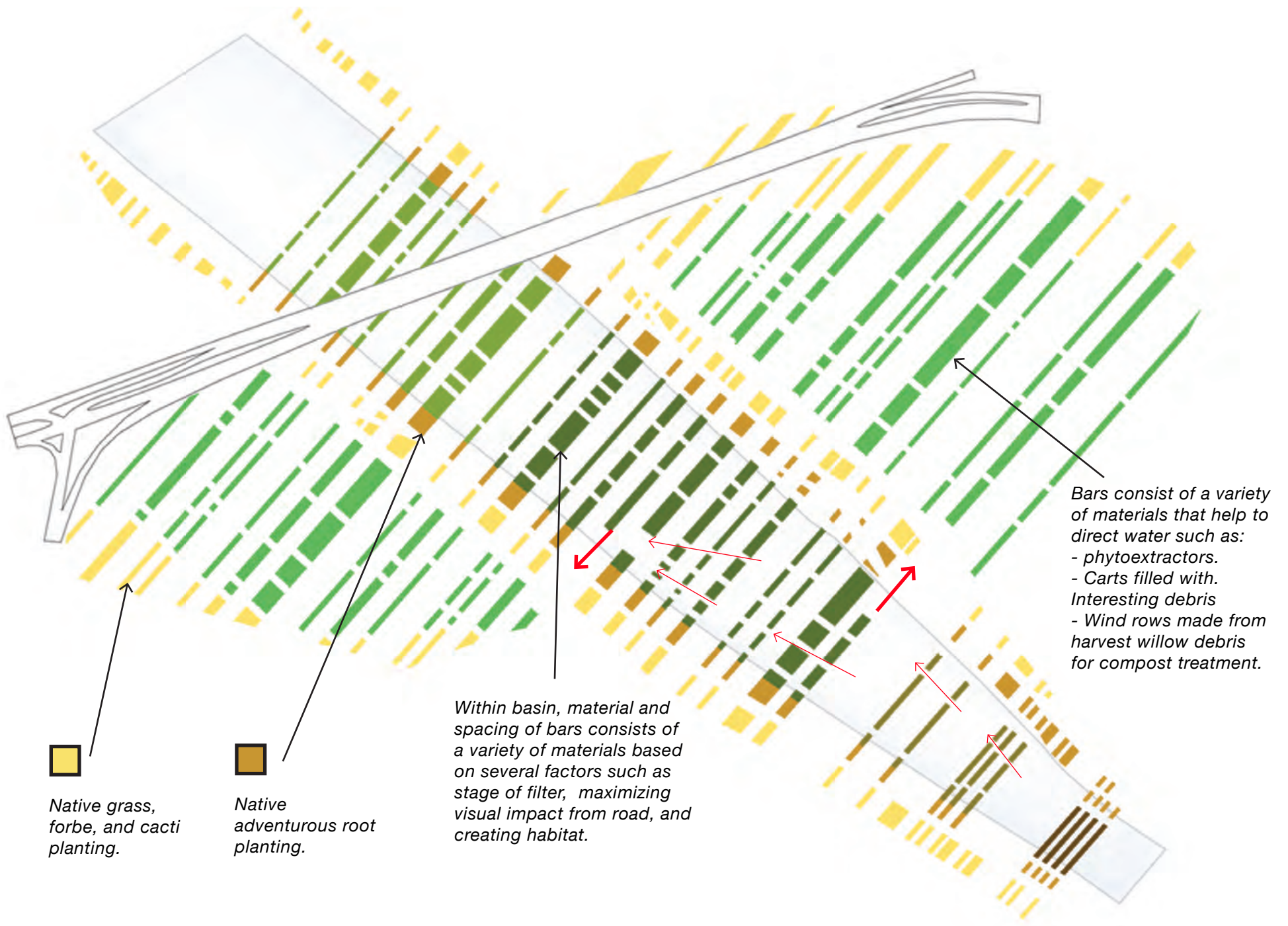
plant and moisture zones as they move outside of the basin. The insides of the levee which consist of large lava rock rip rap will be planted with adventurously rooting plants such as prickly pear and Cholla, as well as tap-rooted plants such as Buffalo Gourd and Datura. On the Outside of the levees, native drought tolerant grasses and forbes will be seeded. It is anticipated that these plantings will shift over time thus illustrating the dynamism that exists within the site's systems.

Part of the hope for this project is to 'close the loop' in terms of waste and pollutant dispersal. Sediment removed from yearly dredging would be spread onto nearby remnant agricultural fields. During the following growing season annual phytoremediation crops such as sunflowers would be grown on the sediment in order to remove pollutant constituents before it is sold as fill dirt. The 'nuisance' flow from the channel will be used to irrigate these remediation crops as well as helping to establish planting in the various areas including bosque restoration.

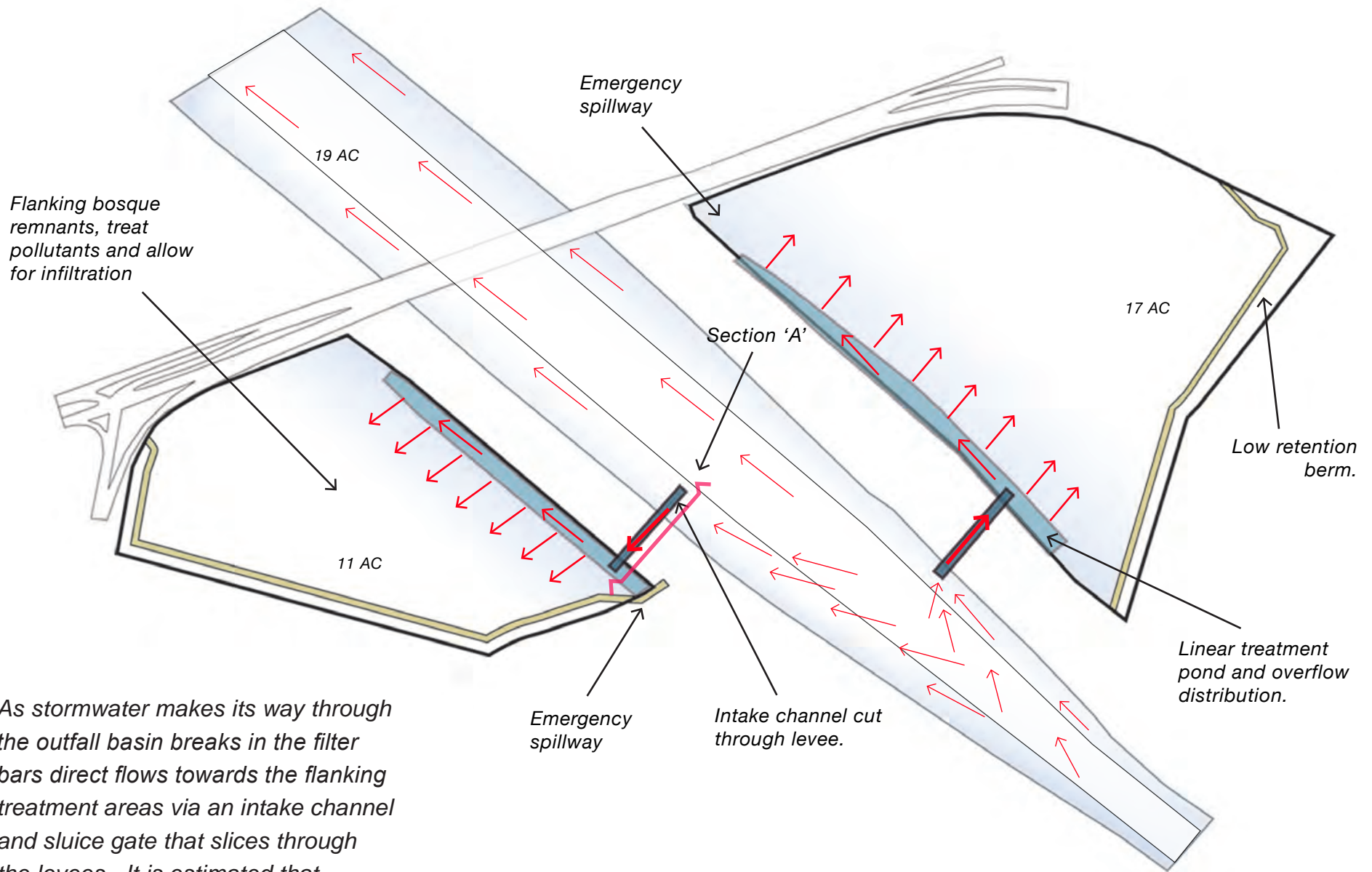
The final stage of the filter will take on chevron shapes based on bridge and rail road geometry. This shift in bar shape is derived from the design strategy of moving the stormwater from highly engineered forms to more naturalistic shapes before entering the more natural receiving waters of the Rio Grande. The inside point of the chevron will begin to collect moisture and sediment throughout the season allowing for a patchwork of small pools and islands to form increasing habitat for wildlife just prior to the Bosque area.

This project hopes to create an engaging open space that accommodates recreation, increases public awareness of natural systems, infrastructure, and that is connected to the existing trail systems, in place of the single-function, restricted access, settlement area that currently exists. This site is important in that it represents the last chance to clean contaminated stormwater before entering the receiving waters of the Rio Grande. Unlike other stormwater facilities in Albuquerque, this site has high visibility, due to several roads that cross over it, thus providing opportunities for exposure to sustainable infrastructure and helping to increasing awareness of its importance. This design proposal for the North Diversion Channel outfall area will significantly reduce pollution, restore wildlife habitat, and create an important open space that will be a great asset to Albuquerque's landscape.

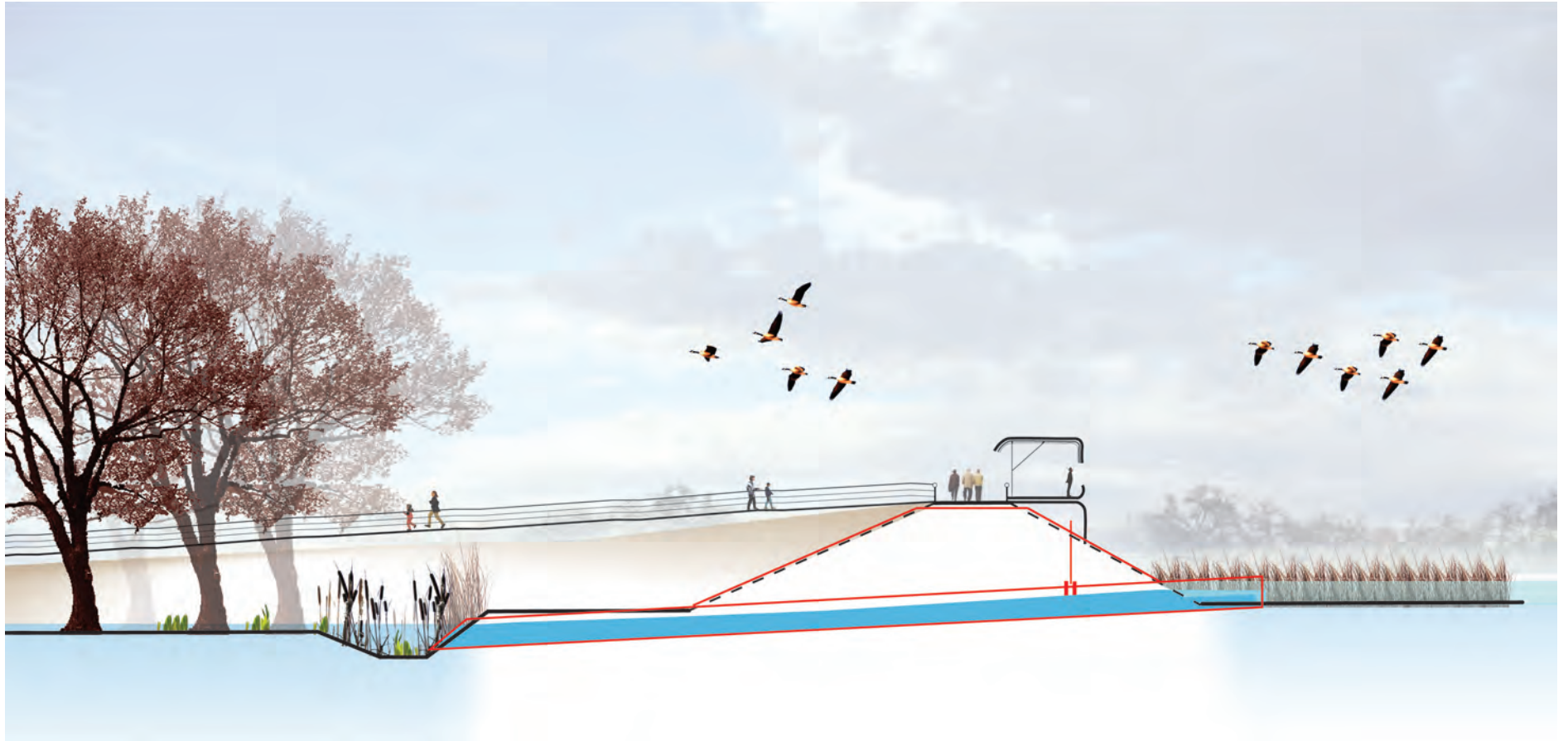




Filter bar types, breaks, and spacing



As stormwater makes its way through the outfall basin breaks in the filter bars direct flows towards the flanking treatment areas via an intake channel and sluice gate that slices through the levees. It is estimated that roughly 20% of storm discharge may be diverted into the flanking zones, which allows for complete filtration of polluted water through natural processes.



Bosque infiltration  
and pollutant  
removal

Linear treatment  
pond

Diversion outlet

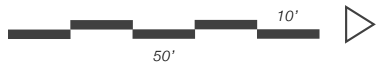
Catwalk  
connection

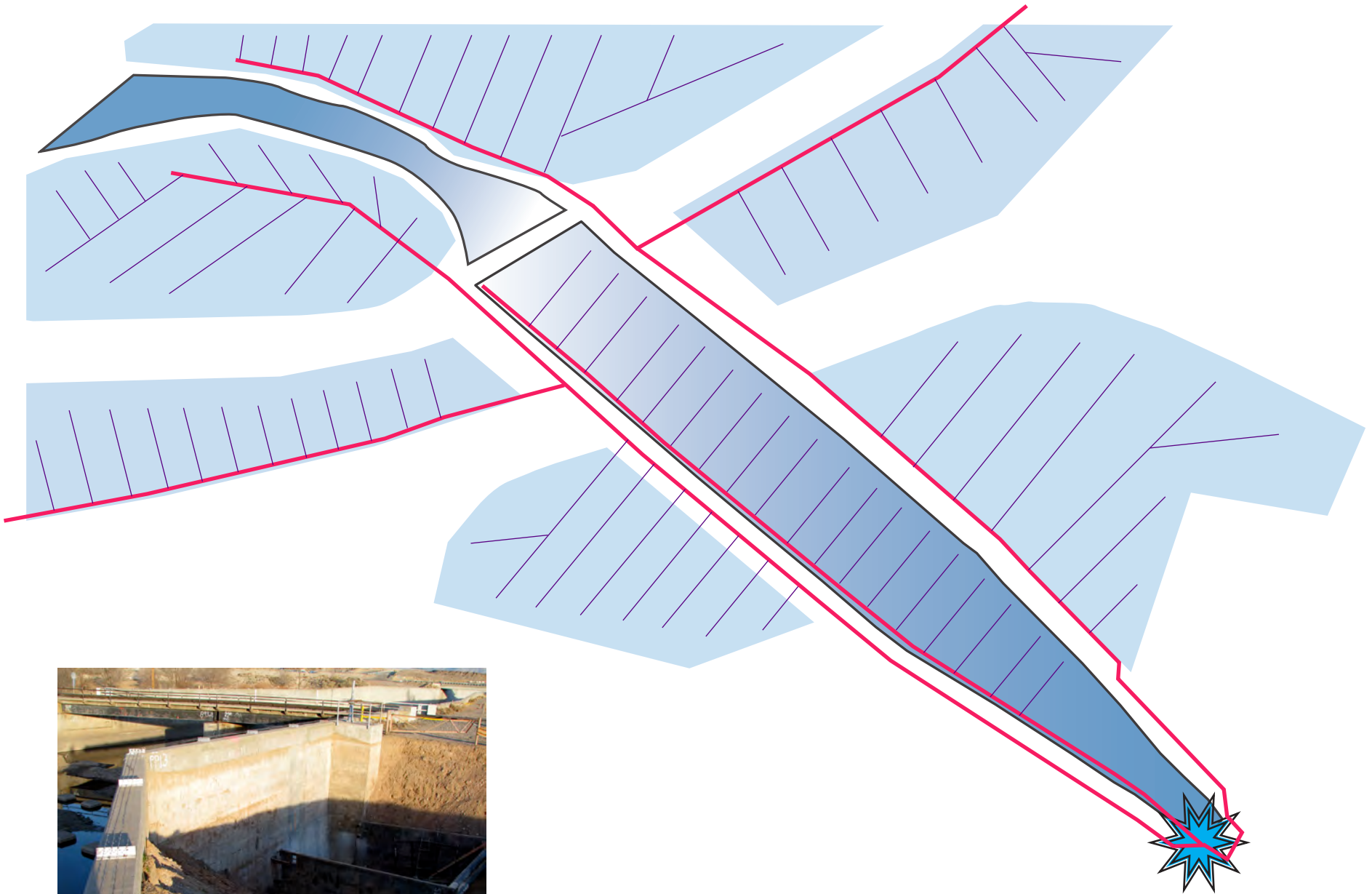
Intake channel cut  
through levee.

Sluice gate and  
control

Intake diversion  
structure

Willow bars



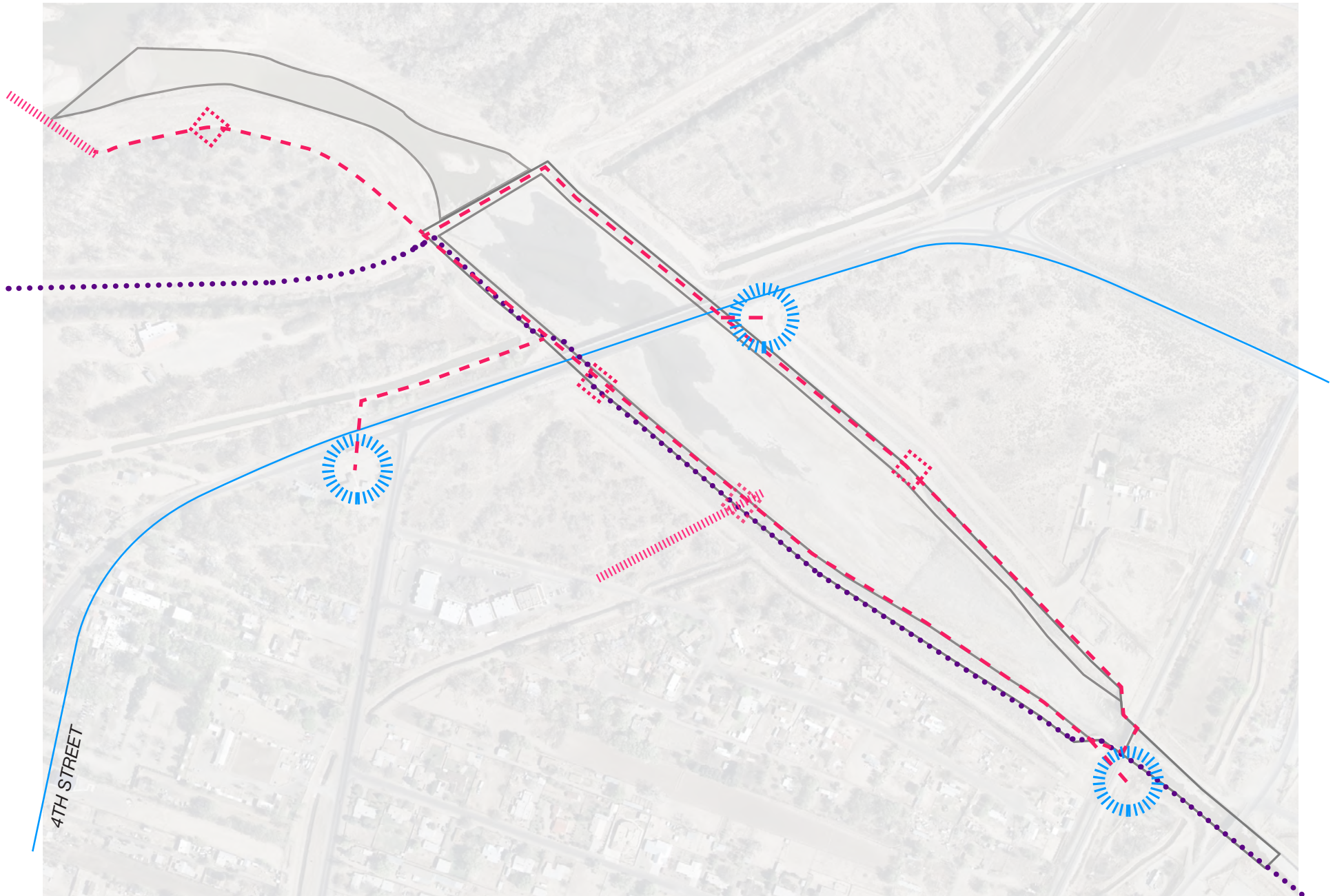




*Willow filled shopping cart filtration bars*



HA Schult 'Trash People'



**Parking Areas**



**Walking Trail**



**Bike Trail**

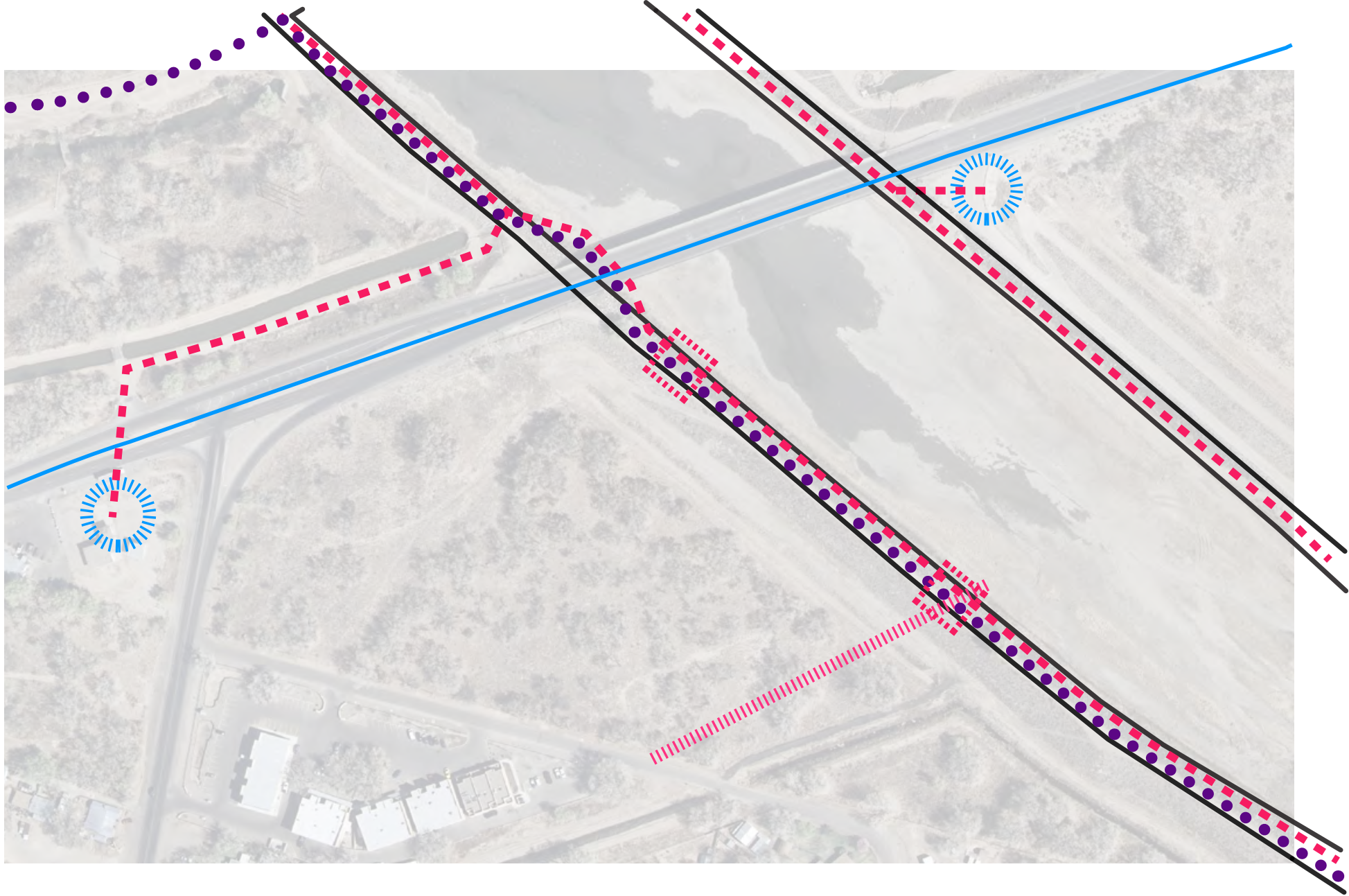


**'Guardrail' Shade Structures**



**Elevated walkways**

*Proposed Circulation*



**Parking Areas**

**Walking Trail**



**Bike Trail**





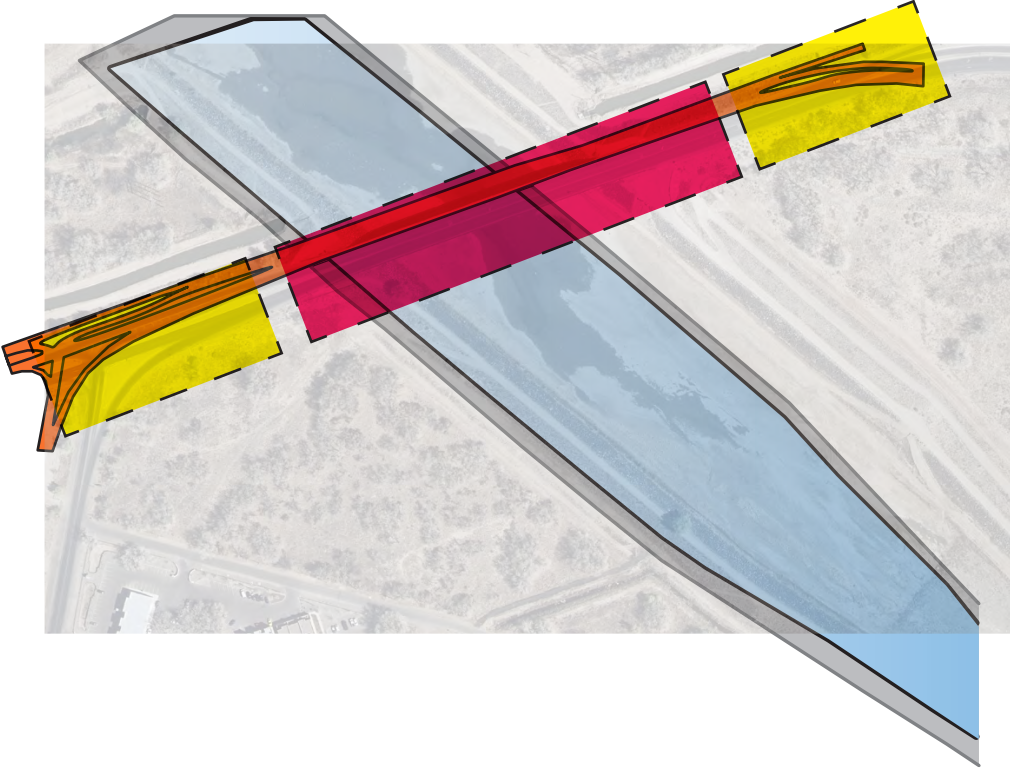
*Proposed Circulation detail showing the elevated neighborhood connection walkway and trails that are routed under the bridge for increased safety.*

*'Guardrail' Shade Structures reuse single purpose material developed for vehicle safety in order to highlight the contribution of the automobile as a major pollution source that enters the river.*





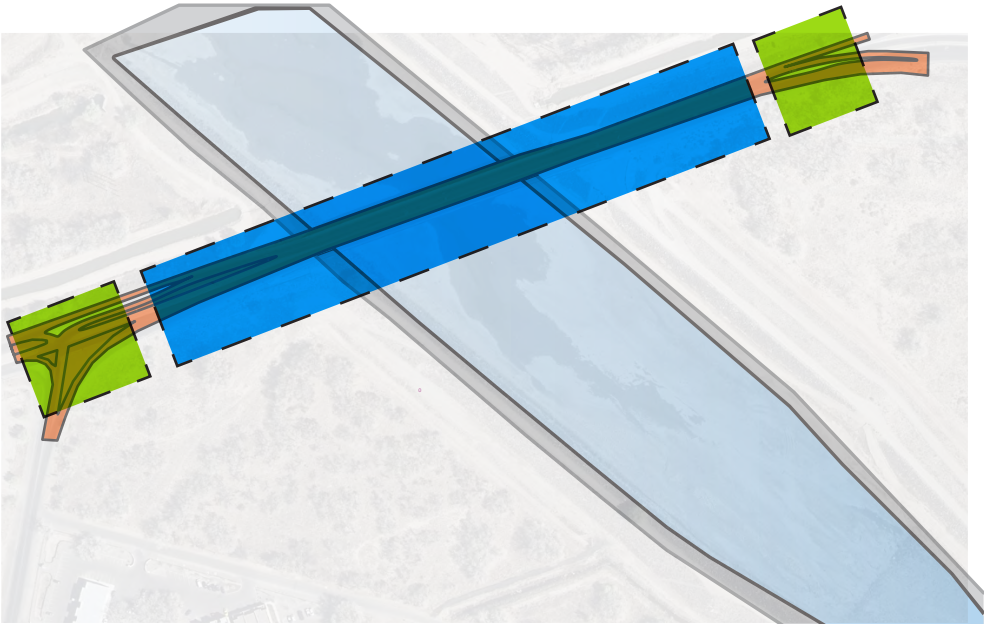
# Existing Traffic Patterns

-  Dangerous high speed intersections
-  Low visibility, high speeds over 55 mph, no space for bikes of pedestrians.



# Proposed Traffic Improvements

-  Traffic signals and crosswalks
-  Bike and pedestrian lanes, slower traffic, and increased visibility of outfall interventions



Existing and proposed bridge improvements.



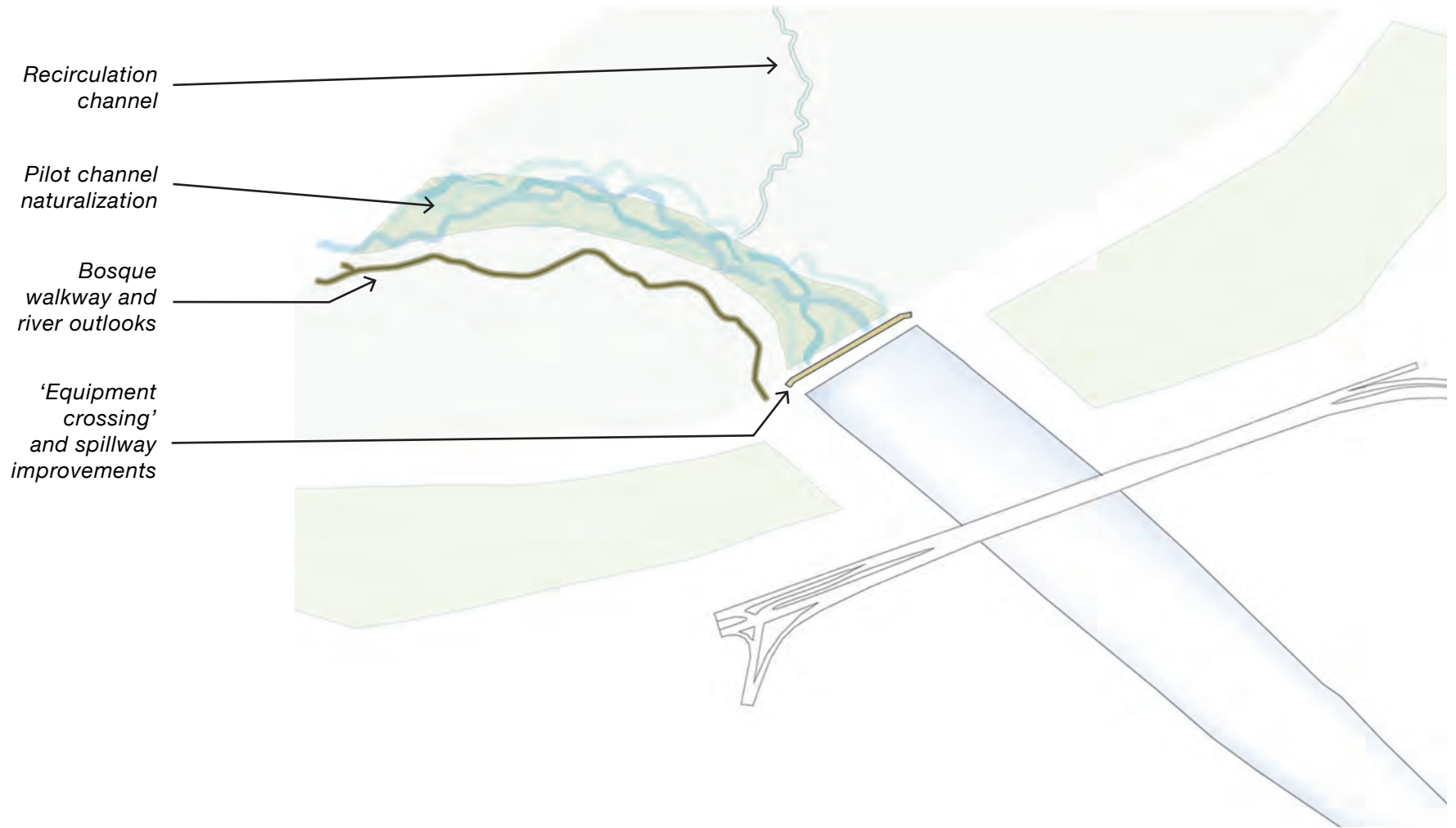
*Proposed bridge improvements feature a pedestrian / bike lane and more permeable railing for increased viewing of interventions*



*Existing bridge conditions are dangerous and obscure the basin bottom*



*Chevron shaped willow-cart filter islands remove pollutants and create habitat.*



*The final stage of the water's journey is the last stage of filtration and also seeks to restore degraded ecosystems and remediate low D.O. problems caused by the original pilot channel design.*



*'Equipment crossing' improvements*



*'Equipment crossing' existing conditions*



*Existing pilot channel conditions. Note: plug at outlet crossing, stagnant water, and low DO problems, as well as the unnatural shape and 'grubbed' area that is devoid of most species that should be present at this site.*



*Recirculation channel and pilot channel naturalization serve to alleviate stagnant water problems as well as restore the ecology of the Bosque.*





*The Bosque walkway and river lookouts reinforce the notion that the Bosque is a pristine nature area.*

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### ***FIGURE CREDITS***

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***(One) Last Chance***