



Flow Archives of Hurricane Harvey in Buffalo Bayou, Houston, Texas: Part 1—Flood, Adjust, and Recover

Katharine P. Kendall¹, Ariane Roesch², Andrew Stearns³, Carolina Ramon-Duenas³, Sarah Meyer³, Jerome J. Kendall⁴, and Jan-Claire Phillips⁵

¹2840 Pueblo Bonito Rd., Santa Fe, New Mexico 87507

²847 Lovers Lane, Houston, Texas 77091

³Department of Earth and Atmospheric Sciences, University of Houston, Science and Research Bldg. 1, 3507 Cullen Blvd., Rm. 312, Houston, Texas 77204

⁴Department of Earth and Planetary Sciences, University of New Mexico, 659 Gonzales Rd., Santa Fe, New Mexico 87501

⁵3331 D'Amico St., Houston, Texas 77019

ABSTRACT

This artwork is an effort to consider the intersecting flows of time, sediment, water, and humans and the impacts of Hurricane Harvey on the city of Houston in the past and into the future.

Sand peel sculptures were created from the sediments deposited by Hurricane Harvey in Buffalo Bayou Park. The sand peel sculptures, along with hydraulic data and human impact data, archive the flooding, adjustment, and recovery phases of Harvey in Buffalo Bayou. The combination of scientific and artistic perspectives in the sand peel sculptures imbue them with a power beyond what either one can create alone. Though both disciplines have similarities, being based on looking and observation, the combination of the two generates a point of access that crosses worlds and brings the perspective of one discipline onto the other and vice versa. With this understanding of flow of people, flow of coastline, flow of time—the sand peel sculptures endure, empowering multiple perspectives of art and science, recognizing the realities of human coexistence with nature and providing an approach to imagining a future for Houston, a cosmopolitan city built on a retreating fluvial coastal plain.

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INTRODUCTION

This is a non-traditional science paper that collaboratively examines the multiple archives of flow created by Hurricane Harvey in Houston. From October 2017 to June 2018, a team of artists and geologists led by Kate Kendall and Jerry Kendall, working in communication with the Buffalo Bayou Partnership and the University of Houston Department of Earth and Atmospheric Sciences, collected 12 sand peels from sediment deposits left by Hurricane Harvey in Buffalo Bayou Park ([Plates 1-12](#)). Our work uses the technique of a sand peel as a basis for interpreting the human and geologic events surrounding a body of water, in this case Buffalo Bayou, and the effects of Hurricane Harvey. The Flow Archive collaborative effort exists to consider the intersecting flows of time, sediment, water, and humans to ponder the impacts of landforms, culture, and geopolitics of the past and present on the future.

THE ART OF SAND PEEL SCULPTURES

A sand peel is typically seen as a geologic science tool used to capture and archive sediment deposit patterns. When also viewed as an art object, a sand peel enables a deeper conversation that connects the science with aesthetic, social, and geopolitical considerations. The power of the sand peel sculptures, as we have named them, is in their ability to hold both perspectives—the science and the art—at once.

From a scientific perspective, sand peels enable answers to questions about how the depositional patterns formed. A geologist interprets the patterns through a geologic lens looking for signs of energy, flow direction, and types of sediment. A geologist is essentially reading and deciphering a complex flow: flow of water, flow of sand, and flow of time simultaneously. Add to this list the flow of human activity and the artistic perspective starts to materialize as well. The idea of human flow can be thought of in multiple ways, from the hands of the artist to the human impact of the storm.

A sand peel could not be created without a human touch. The polymer used to adhere the sediment grains to each other and to cheesecloth to create the structure and solidity of the sand peel sculptures is literally painted onto the sand bar. The brush strokes and the “hand of the artist” are visible in many of the Harvey peels. One could also argue that the strata themselves are the brushstrokes of nature playing the artist. Each peel is thus unique in both its geology (structure, location, and time) and also in its process of extraction, as each location had specific moisture and permeability variations, each time of extraction had specific weather conditions, and each pass with the brush to apply the liquid polymer had a unique stroke and penetration. All these variables give each sand peel its own shape, texture and relief.

In the process of mounting the sand peels, we took the liberty of updating the traditional sand peel display to further code them as art objects. Each of the sand peels taken from Buffalo Bayou was cut to a unique shape to highlight the stratification and/or the shape of the original peel as it was pulled from its site. These shapes were then traced and cut to create custom mounting boards for each peel. This technique leaves little to no edge to frame the peels and allows them to float as finished pieces of art, i.e., sculptures. Any holes in the original peels were also cut out of the mounting boards, preserving the gaps where the polymer did not impregnate the sediment as evidence of the variability in the extraction process.

Custom brackets made of reclaimed oak panels from Harvey debris were secured to the back of each mounting board to hang the finished sculptures on a wall with about an inch of space between the wall and the back of the board. The backs of the boards were painted in either a blue or green glossy paint. This paint reflects a hue of blue or green on the wall behind the peel that shifts in saturation and brightness as the viewer moves around the finished, hanging sculpture. This subtle color glow also complements and magnifies the natural yellows and oranges in the captured sediment. These visual cues of color, outline, and texture can be read and interpreted just as the stratification but in an aesthetic context. They tell the story of the sand peel creation process: the variables of the location and timing of extraction, the context of

flooding water, and the hands of the makers, all of which recognize the specificity of each object.

An artistic read also brings into the mix the social and geopolitical realities of the location where the sand peels were taken. A viewer cannot ignore that these sand peels were made in Buffalo Bayou and were a direct result of a major natural event in the city of Houston; i.e., Hurricane Harvey ([Fig. 1](#)). Let us get into some of that context.

Artistic Read

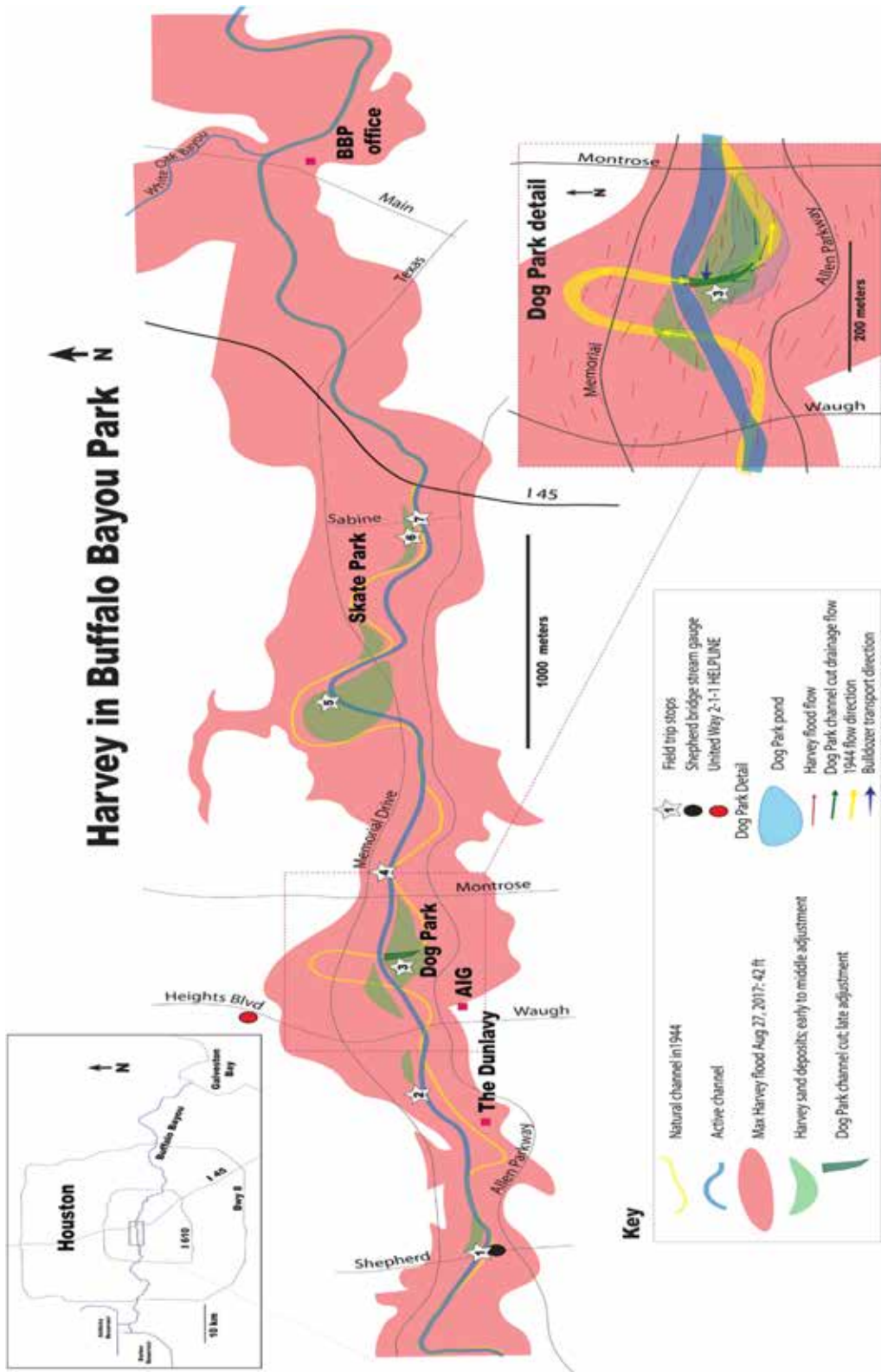
In August 2017 Hurricane Harvey made landfall on the Gulf Coast of Texas. With peak rainfall accumulations of 1539 mm (60.58 in), in Nederland, Texas, Harvey was the wettest tropical cyclone on record in the United States (Roth, 2018). In the areas surrounding Houston, floodwater carried sediment as it swept downstream, utilizing the bayou system to channel and move floodwaters out to the Gulf of Mexico. Some of this sediment built up in Buffalo Bayou Park, creating large deposits and a prime opportunity for making sand peels in our own backyard. The intention was to combine our skill sets to create both science and art objects that would tell a story of Hurricane Harvey in Houston.

Only a few hundred meters from Johnny Steele Dog Park—the extraction site of sand peels 1-6 ([Plates 1, 3-6](#), and [12](#)) and A-E ([Plate 2-6](#))—and the Shepherd St. bridge USGS stream gauge sits the 2-1-1 Texas/United Way HELPLINE Call Center ([Fig. 1](#)). 2-1-1 Texas is a program of the Texas Health and Human Services Commission that connects Texas citizens with the non-emergency services they need. It is a free, anonymous social service hotline available 24 hours a day, 7 days a week, 365 days a year, and is especially relevant during a natural crisis like Hurricane Harvey. The Houston call center is the largest of the 23 centers in the state of Texas, with an average of 40 people manning the phones at any time. The people who work at 2-1-1 are part investigator, part psychologist, and part connector as they work to gather information, make referrals and advocate for callers. During Hurricane Harvey, the flow of calls in to 2-1-1 Texas mirrors the flow of water through the stream gauge, with the highest number of calls during the peak water levels and a corresponding drop in calls when water levels receded ([Fig. 2](#)).

At this time, the 2-1-1 Texas/United Way Call Center was almost fully operational, even though some staff could not make it to work because of the flooding or were experiencing flooding themselves. As the calls come in 2-1-1 also tracks the needs of each caller: Harvey calls related first to instant needs of food and shelter and transitioned after 30 days to basic immediate needs of living expenses with a spike when rent was due. After 90 days, most calls were related to recovery needs including medical, trauma, and home repair. The sand peels, stream gauge and 2-1-1 call center data capture the bayou's geologic record, water level, and human impact of Hurricane Harvey at essentially the same location.

For many people in the Houston area Hurricane Harvey was a tragic natural event that completely disrupted their lives. The 2-1-1 data chronicles the true realities of people during the flood, during the adjustment when waters receded, and in recovery. A year after the storm there was an increase in mental health and counseling service requests at the 2-1-1 call center as people started to resettle and attempt to process the trauma of the flood, the adjustment and their recovery. The geology in the sand peels has also been interpreted into these phases of the Harvey event: flood, adjustment and recovery. However, the layperson is not thinking about the geology and the science of the flood, but the effects it had on their own life and the lives of the people they love. It is difficult to reconcile such an event after so much trauma has occurred, much less attempt to understand it and strategize for the next occurrence.

A storm like Harvey is not the first and it will not be the last major storm to hit the Gulf Coast of Texas. These flood events will happen again; it is in the geology of the Gulf as this article describes. The combination of scientific and artistic perspectives in the sand peel sculptures imbue them with a power beyond what either one can create alone. Though both disciplines have similarities in being based on looking and observation, the combination of the two generates a point of access that crosses worlds and brings the perspective of one discipline onto the other and vice versa. It is in the interpretation that differences appear, and when allowed to co-



(FACING PAGE) Figure 1. Map of the Hurricane Harvey flood and adjustment phases in Buffalo Bayou Park with field trip stops shown as numbered stars (Kendall et al., 2019). The dark blue line is the current active channel, the yellow line is the 1944 channel and the red polygon is the maximum extent of flooding at end of the flood phase (HCFCD, 2017). The green polygons mark the extent of 1–4 m (~3–12 ft) thick sandbars deposited during the early and middle adjustment phase. Note the correlation between sandbar deposits and places where the bayou was artificially straightened in the 1970s. Over 272 million kg (600 million lb) of sediment, enough to fill NRG stadium 3.4 m (11 ft) deep, were removed during the recovery efforts (BBP, 2018). The detail of the Johnny Steele Dog Park area at the lower right shows the sandbar that is cut by a channel (dark green) draining a pond that formed in the dog park during the late adjustment phase. [Figure 6](#) is a larger scale detail of the flow direction in the Johnny Steele Dog Park area.

exist these differences enable a more complex understanding of the context in which the sand peel sculptures exist, both as an archive of the earth and of the cultures that inhabit it. In today's contemporary climate, where change is a persistent and inevitable reality, perspectives that help generate a meaningful narrative about how humans and nature can coexist are extremely prescient.

Geologists have a unique perspective of time, given that the science of geology lies in considering events that occur well beyond the lifespan of humans. Their training hones the skills to read features in the physical world and consider what created those features and when they were formed in scales of millions and billions of years. The details they interpret become visual representations of the time they were formed, so when looking at the landscape geologists see beyond the evidence and infrastructure of humans and life as we know it into the deeper, longer time that creates the infrastructure of the earth itself. We will call this "earth time." Earth time chronicles the long-term effects of earth's natural processes and the physical features produced over time scales well beyond what has or will happen in a month, year, decade or century. This awareness and recognition of a deeper earth time intertwined with human built landscapes enriches a geologist's assessment of the values and needs of our present human moment.

Today, the human time scale dominates our social and political values and choices. We make decisions based on the scale of a human lifetime even as there is an awareness of human history, dating back thousands of years. In the context of describing the natural world there are terms like "100-yr flood" and "500-yr flood;" however, even these terms are too abstract for most people to recognize their value in relation to their own lives. Our contemporary time is only getting faster, with new technology pushing us well beyond physical processes of horse power and steam power into digital speed through internet cables (when asked 'how fast does Google search?' Google returned 4,230,000,000 results in 0.64 sec, as displayed just under the search bar where the search was enacted). This kind of speed and time is what we expect in the contemporary world.

A special feature of these sand peel sculptures is their ability to exist in both earth time and human time. It is rare in the geologic community that a rock or a sediment deposit can be pinpointed to a specific and exact time of creation on any human time scale. The sediment deposited during Hurricane Harvey can be correlated to specific points in earth time using the Shepherd St. bridge stream gauge (Myers et al., 2019; Kendall et al., 2019) thus locating a geologic event in both human time and geologic time ([Fig. 3](#)).

The site of the Harvey sand peels is already new again, washed clean of the records of the wettest storm in U.S. history by numerous other high-water events in the 2 yr since Hurricane Harvey made landfall. The Harvey sand peel sculptures are the only remaining natural archive of the event. The mark of the storm was temporary in nature just as it is in culture as people rebuild their lives, homes, and businesses. The sculptures thus have a unique ability to hold, to persist, and weather through time; they stand as a reminder of the complexity of human coexistence on a coastal plain. There are Pleistocene fluvial deposits along Buffalo Bayou where the sand peels were collected (Horton et al., 2017). These deposits were formed on a coastal plain

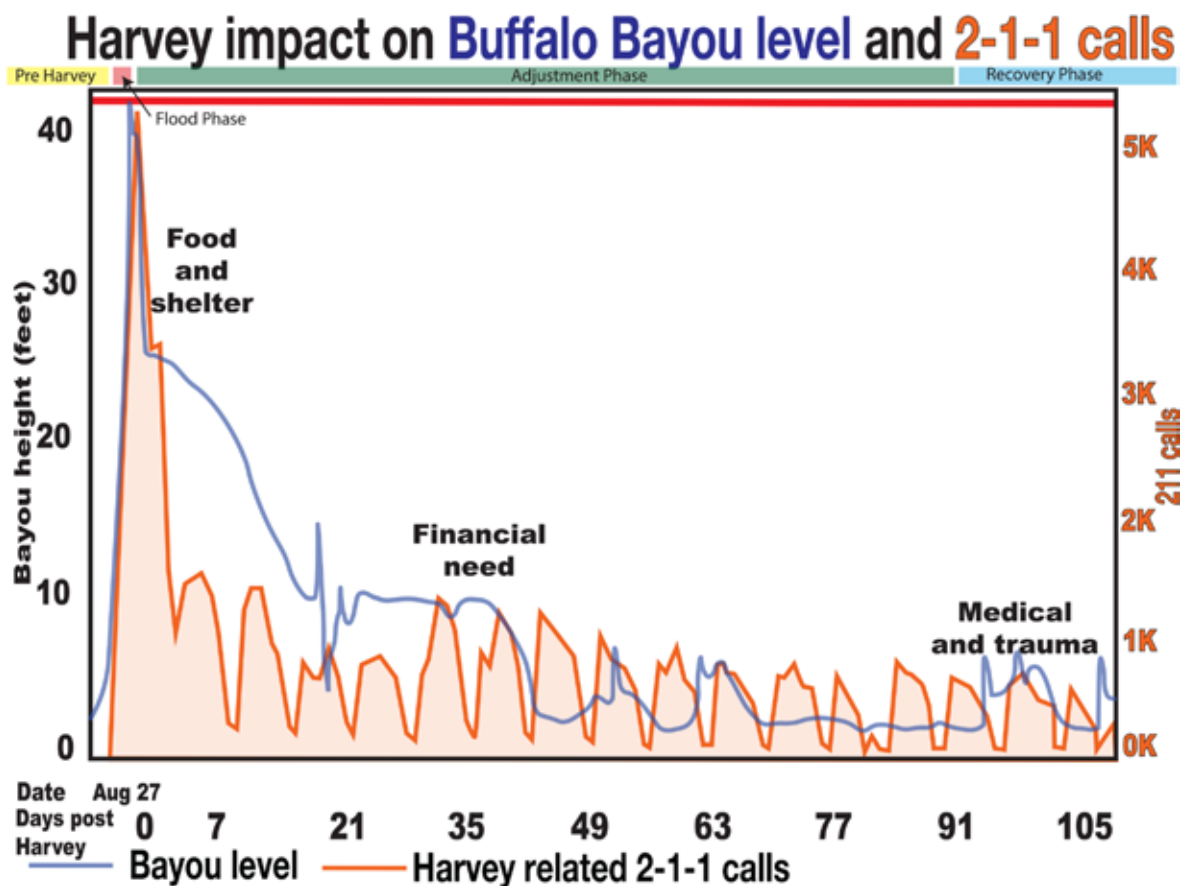


Figure 2. Chart of the water level and human archive of Hurricane Harvey. The chart plots Buffalo Bayou water level at the Shepherd St. bridge (solid dark blue line in feet elevation scale on left; USGS, 2017) vs. time (110 days after Harvey). The red line marks the peak water level of almost 12.8 m (42 ft). At the top of the chart are the flow phases: pre-Harvey (yellow) day -3 and earlier, flood (red) day -2 to 0, adjustment (green) day 0 to 93, and recovery (blue) day 93 to 110+ (Meyer et al., 2019). The colors correspond to those used in the map (Fig. 1) and interpretations (Plates 1B-12B; Figs. 1-6). The human impact archive of the storm is recorded in the Harvey related 2-1-1 Texas/United Way HELPLINE call volume (HCDC, 2017) vs. time (orange line with scale on right). The volume of calls parallels the water level. In addition, the nature of the calls evolves with the flow phases. During the flood and early-middle adjustment (~day 0-14) phases, when the water levels rapidly rose and receded, the need is primarily for food and shelter. During the late adjustment phase, as the bayou returned to its channel (~day 30-40) the character of the need changes to financial as pay checks were missed. By the recovery phase, the need changes to medical and trauma related requests for help. The hydrologic and human impact archives of Hurricane Harvey are the topics of stops 1 and 2 of the Flow Archives of Hurricane Harvey, Buffalo Bayou, Houston, Texas: A Field Guide (Kendall et al., 2019).

when the coastline was approximately 100 km (60 mi) south of where it is today (Paine et al., 2012). Paine et al. estimate shoreline retreat rates have been 3 to 12 m/yr (10 to 40 ft/yr) over the last 16,000 yr (1000 times faster than most geologic processes). With this understanding of

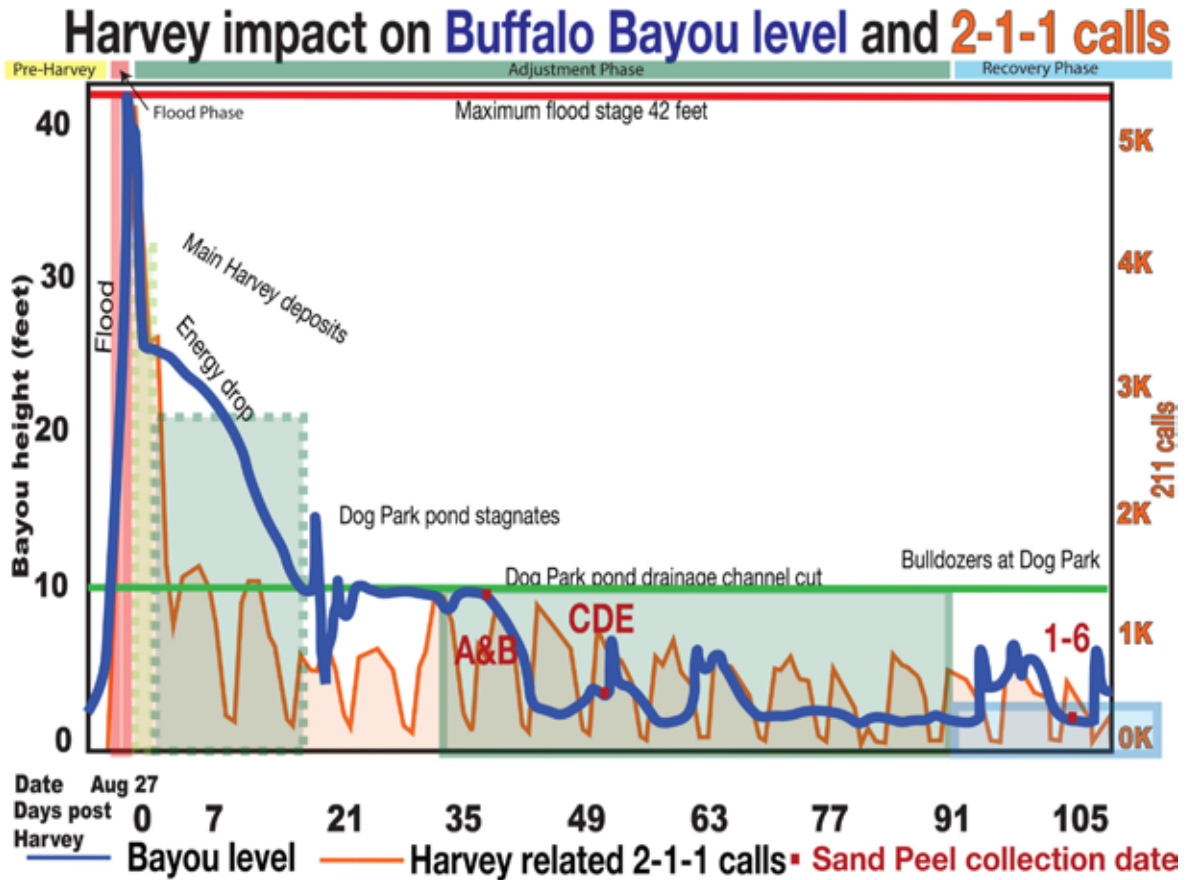


Figure 3. Geologic interpretation overlain on the chart of water level and human impact archive of Hurricane Harvey. This is Figure 2 with boxes added representing the geologic depositional packages. The red box marks the flood phase (day -2 to 0) when the rising waters created the scour (red line) seen near the base of Plates 1, 2, and 7-12. This phase is represented by a gap in the sedimentary record. The rising energy level continuously picked up new grains and carried them downstream. The light green box with dashed lines marks the early adjustment phase (day 0 to 2) when the water level rapidly fell and the high energy deposits were created (Plates 1 and 2). The dark green box with dashed lines represents the middle adjustment phase (day 2 to 18) as the sandbar continued to grow but with lower energy bedforms (Plates 3-7). The dark green box with solid outline represents the main late adjustment phase (days 34-93) when the bayou returned to its channel and redistributed the earlier deposits. The pond formed in the dog park started to drain to the north, cutting a channel through the dog park sandbar. Plates 9-11 show the archive of this phase. The blue box represents the recovery phase (day 94-110+) when bulldozers were reworking the deposits. The top 1/3 of Plate 12 records this phase.

the region and flow—flow of people, flow of coastline, flow of time—the sand peel sculptures endure, empowering multiple perspectives of art and science, recognizing the realities of human coexistence with nature and providing an approach to imagining a future for Houston, a cosmopolitan city built on a receding fluvial coastal plain.

The sand peel sculptures through their ability to hold both a geologic and artistic perspective at once offer a more complex narrative for Harvey and its impact on Houston. The sand strata provide both a direct natural narrative and a more abstract and objective view than emotional images of flooded homes and stranded people clutching belongings. And most importantly the abstraction and the consideration of the natural world enable thinking in earth time, the kind of time that is relevant to understand these kinds of events in relation to the past and the future of the city of Houston.

Reading the Geologic Archive

In each sand peel geologists observe the grain size and patterns in the depositional layers to interpret the energy level and direction of flow. The location of each sand peel relative to the sandbar and erosional surfaces (Fig. 4) sets a framework for what to look for in the sand peels. Muds indicate little or no current. Small scale ripples indicate low energy flow. Large planar shapes indicate high energy flow. The third shape of a bedform gives information on the direction of flow. Meyer (2019) examined sand peel 2 (Fig. 5) and saw evidence of pre-Harvey events in the muds at the base of the peel, the Harvey flood in the irregular truncation, the early high energy adjustment phase in the planar layers, the late adjustment phase in the second truncation surface, and the recovery phase in the unstructured top section of the peel.

Scientifically reading the sand peels (Plates 1B and 12B) Meyer was able relate this geologic archive to specific points in earth time using the Shepherd St. bridge stream gauge (Figs. 2 and 3), pinpointing a geologic event in human time and geologic time. The relative time scales represented in Buffalo Bayou are: seconds to minutes for individual layers, hours to days for bundles of layers, years to lifetimes for meters (feet) of sediment, hundreds to thousands of years for the rocks the bayou is cutting into, millions to billions of years for the ages of some of the sand grains themselves. As discussed above, the flow of time and how it is archived is a subject where art and science interrelate in the fluvial tapestries of Buffalo Bayou.

In addition to time, flow directions are archived at the Johnny Steel Dog Park. Flow was to the south before the bayou was diverted, then to the east during the Hurricane Harvey flood and early and middle adjustment phases, then to the north in the channel cut during the late adjustment phase, and finally to the west during the recovery phase (Fig. 6).

The Bigger System

The 4 km (2.5 mi) section Buffalo Bayou that flows through the park is part of a ~100 km (60 mi) drainage system that connects to Galveston Bay and ultimately to the depths of the Gulf of Mexico. The entire system responded to Hurricane Harvey. The upstream portion near the Addicks and Barker dams was dominated by erosion (Fig. 7; Stearns, 2019). The portion through the park saw deposition and erosion (Fig. 4) while the downstream portion is more dominated by deposition (Ramon-Duenas and Wellner, 2019). A post-Harvey satellite image of the Buffalo Bayou system (Fig. 8) shows the brown water draining out from Buffalo Bayou into the Gulf of Mexico. It is important on a human time scale to understand the sediment dynamics as we deal with a shoreline that is retreating inland (Paine et al., 2012).

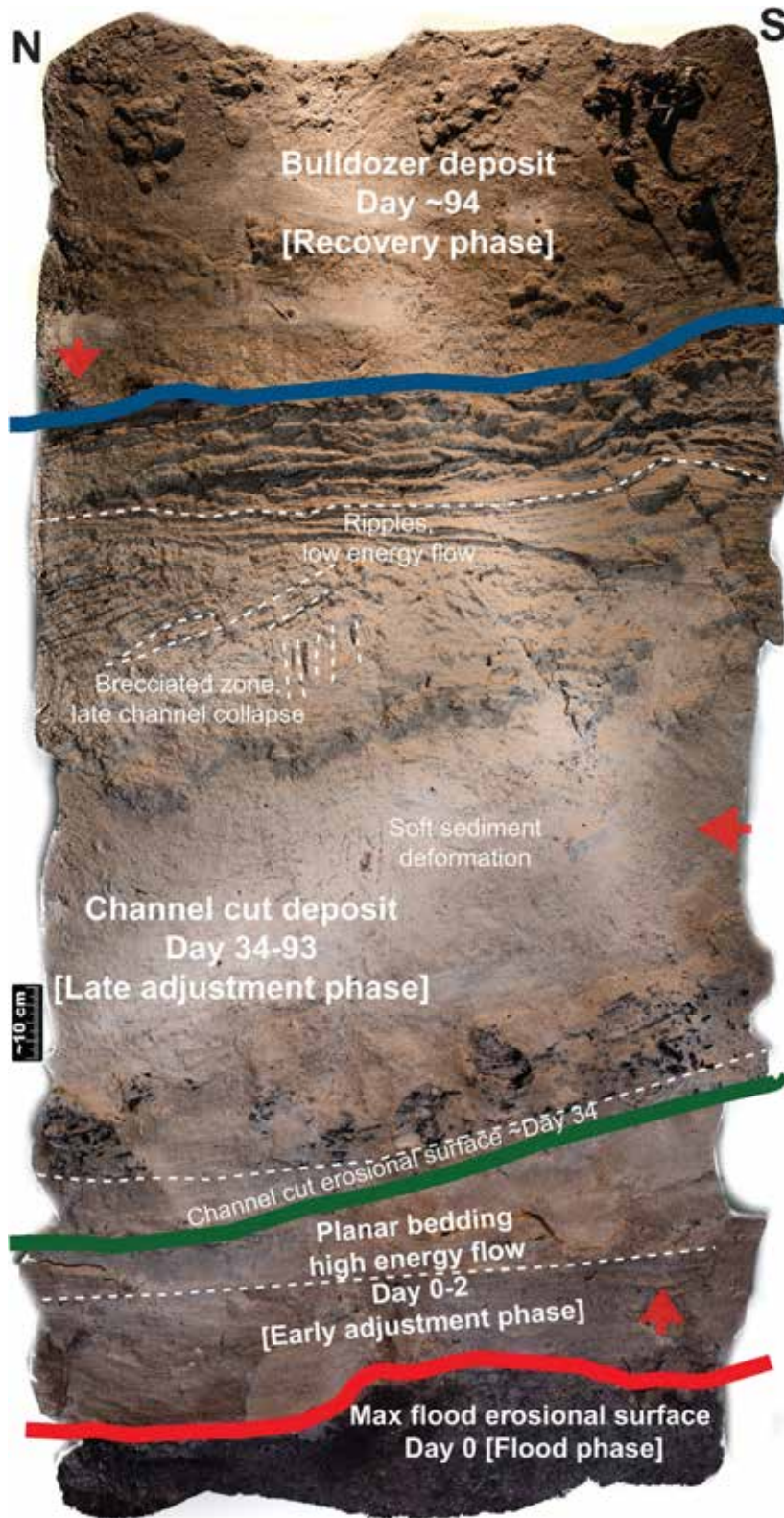
THE NEXT ONE

The sand peel sculptures, through their ability to hold both a geologic and artistic perspective at once, offer a complex narrative for Harvey and its impact on Houston. The consideration of the natural world enables thinking in earth time, the kind of time that is relevant to understand flooding events in relation to the past and the future of the city of Houston.

As artists and geologists, we are interested in the intrinsic value of art and aesthetics to share this complex narrative of time, flow, sediment and human experience and ask viewers to



Figure 4. View looking north out of the dog park drainage channel at Buffalo Bayou. This shows the sand bar deposited at the Johnny Steele Dog Park (stop 3 on [Fig. 1](#)) ~100 days after Harvey. The sand peel 1 site ([Plate 1](#)) is on the left and that of peel 2 ([Fig. 5](#); [Plate 12](#)) is on the right. The red lines mark the basal erosional surface of the flood phase. On the left and right are primarily sand bar deposits with the dotted green line marking the approximate top of the bar at the end of the middle adjustment phase. The base of the channel cut is marked by the dashed and solid green lines. On the left are remnants of the sand bar (between the red and solid green lines). This is overlain by the dog park channel cut deposits (between solid green and blue lines). Above the blue line are sands reworked by bulldozers. Across Buffalo Bayou a bridge spans a small tributary that lies in the old (1944) channel. To the right of the bridge at water level are outcrops of Pleistocene red mudstone coastal plain deposits of the Beaumont Formation. During the Pleistocene (2,500,000 to 11,000 yr ago) fluvial deposits were formed on a coastal plain when the coastline was on the order of ~100 km (~60 mi) south of where it is today (Paine et al., 2012). Paine et al. (2012) estimate shoreline retreat rates have been 3 to 12 m/yr (10 to 40 ft/yr) over the last 16,000 yr. This is geologically extremely fast, 1000 times faster than most geologic rates. The sequence of events and flow directions evolution are discussed in [Figure 6](#).



(FACING PAGE) Figure 5. Sand peel sculpture 2 (Plate 2) interpretation as flood, adjustment, and recovery. At the base of peel 2, there is a mud layer with a large basal scour in it. This mud layer was deposited pre-Harvey, and it is topped by an erosional surface. Above this erosional surface there is planar bedding indicating upper flow regime and high flow velocity. This is the river bar deposit. Above this there is a thin mud layer within the sand followed by a large scour rich in organics. This marks the late adjustment phase with the start of the channel cut deposit. Within the channel cut deposit there is a thick package that has undergone soft sediment deformation. The soft sediment deformation was caused by a rapid influx of sediment on top of this package, causing compaction, pushing the water out and deforming the sediment. Moving up the section, there is a well-defined brecciated zone, where laminations were broken up and transported as a result of late channel collapse. Above the brecciated zone, there are gently climbing ripples that indicates a fast sedimentation rate and a high amount of suspended sediment. Above the ripples there are no sedimentary structures because this sand was deposited by a bulldozer during Hurricane Harvey recovery phase. Red arrows indicate directions of flow.

Event Timing Interpretation:

Flood phase, August 28, 2017: Buffalo Bayou reached its maximum water level at about 1:00 AM, with a measured gauge height of ~12.8 m (41.9 ft; USGS, 2017). The rising water level leading up to August 28 meant a high energy system causing erosion of the material that had already been deposited there prior to the flood. Erosion ceased and deposition began following the maximum gauge height as the water level began to drop. This is marked by the red line that outlines the erosional surface. Flow was to the east.

Early adjustment phase, August 28–30, 2017: By the morning of the 28th through the 30th the water level dropped rapidly and the flow conditions were in the upper flow regime (high energy). On peel 2, the sediment deposited during this time is from the red line to the green line. Flow was to the east.

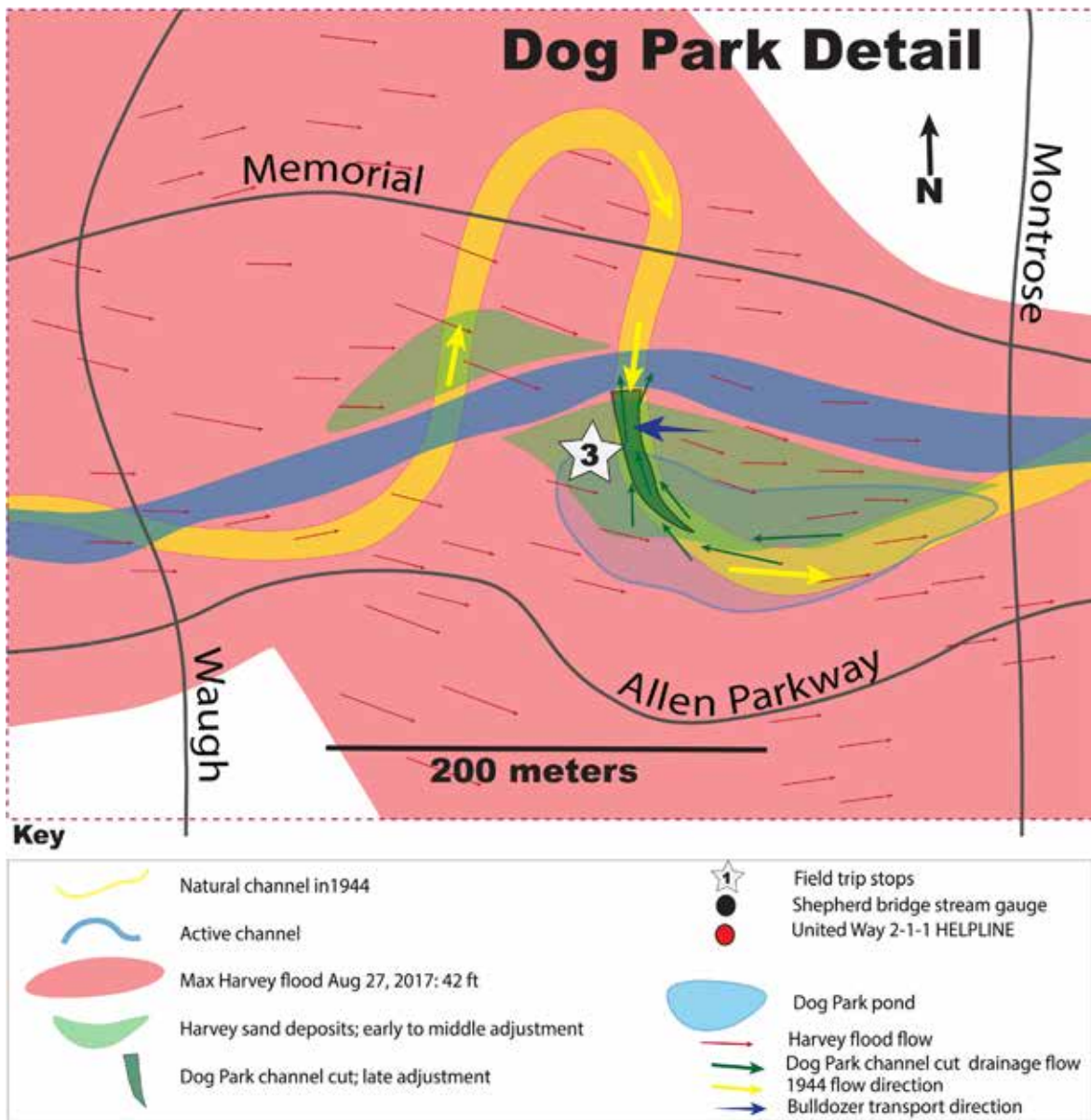
Late adjustment phase, October 1–November 29, 2017: The bayou returned to its channel and water stranded in a pond formed in the dog park eroded through the sand bar. On peel 2, these deposits are from the green line to the blue line. Flow was to the north.

Recovery phase, November 30, 2017: The recovery phase is archived in the unstructured sands, above the blue line, that were pushed west into the dog park channel cut by bulldozers grading the area during the sand removal process. Over 272 million kg (600 million lb) of sand were removed during the recovery efforts (BBP, 2018). The flow of sediments was to the east.

consider that Hurricane Harvey is not unique. It is one of thousands of such events, and it will happen again. The human time scale is not dominant; it flows alongside a natural scale, an earth time. This artwork reminds us that we need to consider our habitation of the Gulf Coast in earth time, embrace its complexity, and be prepared to coexist with an ever-changing coastline.

ACKNOWLEDGMENTS

The Flow Archive collaborative effort exists to consider the intersecting flows of time, sediment, water, and humans to ponder the impacts of culture and geopolitics of the past and present on the future. We thank the organizers of GeoGulf 2019, who expanded the traditional scope of their convention to include an art installation, art paper, and field trip of our art/science collaboration with a social message. We want to thank Jan-Claire Phillips for endless logistical,



moral, and editorial support; Don Yurewicz for his photography; and Andrés and Jack Machin, Tom Byrd, Charlie and Linda Beeman, Ky Cooksey, and Erin Miller for physical and moral support.

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For past exhibitions, information, and images of the artwork, visit <https://www.katekendall.info>. For more information about Flow Archive and future projects, visit <https://flowarchive.com>.

(FACING PAGE) Figure 6. Detail of dog park area showing water bodies and flow directions at different phases. The dog park channel cut is unique in that it archives flow in 4 different directions over time. Flow to the south (yellow arrows): Until Buffalo Bayou was straightened in the 1970s, the Buffalo Bayou channel formed a sharp meander through what is now the dog park drainage channel (yellow line next to stop 3 on map).

Flow to the east (red arrows): During the flood, early, and middle adjustment phases Harvey floodwater rose to and then dropped from 12.8 m (42 ft) to ~3 m (~10 ft), depositing the thick sandbar and filling the old dog park channel.

Flow to the north (green arrows): Late adjustment phase: When the bayou dropped below ~3 m (~10 ft) approximately 30 days after Harvey, the pond that formed in the dog park started draining to the north (dark green polygon), cutting through the sandbar. This channel continued to cut and fill for approximately 60 days.

Flow to the west (large blue arrow): During the recovery phase, the bulldozers reworked and removed the sands, transporting them to the west.



Figure 7. Representative view of the source of sediments in the upper portions of the Buffalo Bayou fluvial system. This photo shows the south bank of Buffalo Bayou several miles downstream of the Barker and Addicks dams. The area is characterized by extensive roots exposed by erosion. Stearns (2019) attempted to quantify the volume of erosion in source area of Buffalo Bayou. Paddle blade ~0.20 m (~8 in) wide for scale.



Figure 8. Satellite image of the Buffalo Bayou system and Texas Gulf Coast 4 days after Hurricane Harvey, at the end of the early adjustment phase (modified from Carlowicz and Allen, 2017). The brown water shows a sediment plume that overwhelmed the longshore current direction. The work of Ramon-Duenas and Wellner (2019) at the University of Houston focuses on understanding the sediment transport and the coastal responses to storms in the flood tidal delta. Their pre- and post-Harvey data at San Luis Pass provides hints at how the area responds to storm episodes. San Luis Pass is just northwest of the trailing end of the arrow labeled “Fair Weather Longshore Current.”

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APPENDIX

Plate 1

Plate 1A illustrates the uninterpreted sand peel sculpture 1 and **Plate 1B** shows sand peel sculpture 1 with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture1>.



Summary

This peel shows low energy pre-Harvey deposits at the base and following the erosional surface a transition into a high energy environment with upper flow regime bedforms. At the very top there is a transition into the lower flow regime evident by formation of ripples.

The base of peel 1 is a mud layer rich in organics; this mud layer was deposited prior to the Harvey event. At the top of the mud layer there is an erosional surface. Above the erosional surface is where the Harvey deposit begins. The mud layer was deposited under very low energy conditions. Immediately above the erosional surface there is a transition to planar cross stratification, indicating upper flow regime. The transition from mud (lower flow regime) into planar cross strata (upper flow regime) tells us there was a rapid influx of sediment moving at high velocity following the erosional surface. Throughout most of the peel, there is consistent planar cross stratification, with some soft sediment deformation. This soft sediment deformation reinforces that there was rapid influx of sediment that was saturated and as it compacted, dewatering occurred causing soft sediment deformation features. In the top, left corner of the peel, there is another erosional surface where a trough cuts across the planar strata. Within this trough, there are small ripples, indicating lower flow regime. The red arrows indicate the flow direction.

Event Timing

Flood phase, August 28, 2017: The red line marks the erosional surface above the low energy pre-Harvey deposit. This erosion occurred while the flood phase was rising up until when Buffalo Bayou reached its peak of the flood phase at about 1:00 am on August 28, with a measured gauge height of 15 m (41.90 ft). Flow was to the east.

Early adjustment phase, August 28–30, 2017: By the morning of the 28th through the 30th, the water level dropped rapidly from 11.9 m (38.76 ft) on August 28 to 7.7 m (25.33 ft) on August 30. This is a rate of decrease of about 1.36 m (4.48 ft) per day. During this period of time, as the flood waters dropped rapidly, the flow conditions were in the upper flow regime and a lot of sediment was accumulated as bar deposits. On peel 1, the sediment deposited during this time is from the red line to the green line. Flow was to the east.

Middle adjustment phase, August 30–September 5, 2017: The water level dropped much more gradually. The rate of decrease was about 0.256 m (0.84 ft) per day. During this period of time, the flow conditions were in the lower flow regime. On peel 1, these deposits are ripples and are above the green line. Flow was to the east.

Plate 2

Plate 2A illustrates the uninterpreted sand peel sculpture A and **Plate 2B** shows sand peel sculpture A with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture2>.



Summary

Peel A is a waning flow deposit, meaning that the energy of the flow in Buffalo Bayou was decreasing over time. The sedimentary features preserved in the peel are evidence of this.

At the base of peel, A, there is a layer of organic rich medium to fine sand truncated by an erosional surface. Below this erosional surface is pre-Harvey deposit. Above the erosional surface, there is planar cross stratification, indicating upper flow regime. There is banding of grain size between fine to very fine sand within the planar cross strata, indicating an alternating flow strength throughout deposition. Within the planar cross stratification, there is a small amount of organic material deposited because the composition of the flow changed. There is a transition from planar cross stratification to low angle trough cross stratification due to the formation of a prograding dune. This indicates a decrease in the energy conditions as the bedforms transitioned from upper to lower flow regime. At the top of the peel, there is a greater decrease in energy and flow velocity evident by a transition into small troughs from current ripples. Within the dunes there are two small collapse faults that formed after deposition because of extension, likely caused by a nearby slump. This was most likely a response to gravitational failure into the cross-cut channel and would have occurred after the gauge height was below 10 ft, after October 1. The red arrows indicate the flow direction.

Event Timing

Flood phase, August 28, 2017: Buffalo Bayou reached its peak of flood phase at about 1:00am, with a measured gauge height of 15 m (41.90 ft) (USGS). On peel A, this date and time is marked by the red line that outlines the erosional surface. This high flood phase meant a high energy system, causing erosion of the material that had already been deposited there prior to the flood. Flow was to the east.

Early adjustment phase, August 28–30, 2017: By the morning of the 28th through the 30th, the water level dropped rapidly from 11.8 m (38.76 ft) at 7:45 am on August 28 to 7.7 m (25.33 ft) at 9:30 am on August 30. This is a rate of decrease of about 1.4 m (4.48 ft) per day. During this period of time, as the flood waters dropped rapidly, the flow conditions were in the upper flow regime and a lot of sediment was accumulated as bar deposits. On peel A, the sediment deposited during this time is from the red line to the green line. Flow was to the east.

Middle adjustment phase, August 30–September 16, 2017: The water level dropped much more gradually starting at 3.1 m (25.33 ft) on August 30 to 3.1 (10.28 ft) on September 16. This is a rate of decrease of about 0.256 m (0.84 ft) per day. During this period of time, the flow conditions were in the lower flow regime and a lot of sediment accumulated as bar deposits. On peel A, these deposits are from the green line to the top of the peel. Flow was to the east.

Late adjustment phase, October 1–November 29, 2017: The slumping into the new channel cut immediately to the north causes small faults of the middle adjustment phase sand bar. Flow was to the north.

Plate 3

Plate 3A illustrates the uninterpreted sand peel sculpture B and **Plate 3B** shows sand peel sculpture B with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture3>.



Summary

The entire peel is within the lower flow regime with the predominant sedimentary structure being trough cross stratification formed by dunes, with some ripples within the dunes.

There is low angle, large scale trough cross stratification from dunes throughout peel B. Within the troughs of these dunes, there is smaller scale cross trough stratification from ripples. Ripples indicate lower flow energy than dunes. The ripples within the dunes indicate an alternating strength of flow. Organic material is deposited throughout, resting in the troughs. When the dunes formed there was stronger flow and when the ripples formed there was weaker flow. These were likely local changes in flow velocity. Overall, there is a slight increase in energy of the system over time because the ripples are more prominent at the base of the peel.

Note: The maximum flood erosional surface is -0.4 m below the peel. The red arrows indicate the flow direction.

Event Timing

Middle adjustment phase, September 2–8, 2017: This peel was deposited from September 2–8. During this time period, the flow conditions were in the lower flow regime, which includes ripples and dunes. During this time, there would have likely been a transition from upper to lower, lower flow regime so both ripples and dunes were deposited together. Flow was to the east.

Plate 4

Plate 4A illustrates the uninterpreted sand peel sculpture C and **Plate 4B** shows sand peel sculpture C with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture4>.



Summary

Peel C is a waning flow deposit, evident by the transition from dunes to ripples.

Starting at the base until about three-quarters up the deposit there is large scale trough cross stratification resulting from dunes. Above these dunes, at the top of the peel, there are smaller cross trough strata resulting from ripples. The transition from dunes (upper, lower flow regime) into ripples (lower, lower flow regime) indicates a decrease in the energy and velocity of the flow. The red arrows indicate the flow direction.

Note: The maximum flood erosional surface is -0.3 m below the peel.

Event Timing

Middle adjustment phase, August 31–September 8, 2017: During this time, Buffalo Bayou was forming bedforms of the lower flow regime so this peel was deposited within this range of dates. Flow was to the east.

Plate 5

Plate 5A illustrates the uninterpreted sand peel sculpture D and **Plate 5B** shows sand peel sculpture D with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture5>.



Summary

Peel D displays increasing energy and velocity through time as there is a transition from mud and silt into fine to medium sand and the development of 2D climbing dunes and then 3D dunes.

At the base of the peel, the first package of strata contains low angle cross stratification. The strata are banded and there are layers of very fine, dark colored silt and clay within the fine to medium sand. This implies that this package was deposited under low energy conditions and the banding is likely due to a local variation in flow rate. Moving upsection from this, the flow velocity has increased because there is only sand deposited and no mud or clay. More evidence for increased flow velocity is the deposition of 2D climbing dunes with tangential laminations. There are nine clear packages of 2D climbing dunes and then there is an increase in velocity as there is a transition from thin packages with tangential laminations and planar cross strata, to thicker packages with non-tangential laminations and trough cross strata. These thicker packages are 3D dunes that indicate a further increase in velocity. The red arrows indicate the flow direction.

Note: The maximum flood erosional surface is -0.2 m below the peel.

Event Timing

Early transitioning to middle adjustment phase, August 30–September 1, 2017: This time period is at the transition from upper to lower flow regime. Throughout the period of upper flow regime, the energy is decreasing; however, at the transition there is a slight increase in flow energy and therefore energy, so this peel was likely deposited at this time. There could also have been some local fluctuation in flow energy. Flow was to the east.

Plate 6

Plate 6A illustrates the uninterpreted sand peel sculpture E and **Plate 6B** shows sand peel sculpture E with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture6>.



Summary

Peel E is a rising energy deposit with increasing energy through time. This is evident because there is a transition from current ripples to dunes that increase in size moving up the peel.

At the base of peel E there are small current ripples, however they are difficult to see because they were cut oblique to the peel. Ripples indicate lower flow regime. Moving upsection from this there is a transition to large scale trough cross stratification from dunes. The dunes get larger moving up the peel indicating a rise in stage. Overall, the energy is increasing as there is a transition from ripples to dunes. The red arrows indicate the flow direction.

Note: The maximum flood erosional surface is -0.4 m below the peel.

Event Timing

End of early adjustments phase, August 30–September 1, 2017: This time period is at the transition from upper to lower flow regime. Throughout the period of upper flow regime, the energy is decreasing however at the transition there is a slight increase in energy, so this peel was likely deposited at this time. There may have been some local variations in flow energy. Flow was to the east.

Plate 7

Plate 7A illustrates the uninterpreted sand peel sculpture X and **Plate 7B** shows sand peel sculpture X with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture7>.



Summary

Peel X shows an overall increase in energy and velocity from the base to the top of the peel. At the base, there are organics and roots, indicating lower energy, and at the top there are dunes, indicating higher energy.

The base of peel X is full of organic material, including some plant roots that are oriented vertically. These roots indicate that this was deposited prior to Hurricane Harvey during a previous storm event. There appears to be wavy laminations throughout this organic rich package of sediment; however, these are not laminations they are a result of soft sediment deformation. This organic rich sediment was saturated and then disturbed and deformed when the energy increased, bringing an influx of sediment on top of it. The maximum flood erosional surface is near the middle of the peel (red line). Above the scour surface, there is large scale trough cross stratification at the top of the peel, so this sediment was deposited as dunes with some organic material deposited in the troughs. The red arrows indicate the flow direction.

Event Timing

Pre-Harvey phase, May 27–30, 2015: Buffalo Bayou reached a water level of 10.3 m (33.77 ft) on May 26, 2015, which marks the biggest storm event leading up to Hurricane Harvey. It is likely that the base of the peel was deposited due to this storm event.

Flood phase, August 28, 2019: Formed scour surface. Flow was to the east.

Middle adjustment phase, August 31–September 5, 2017: The dunes in the top of the peel were likely deposited during this time of lower flow regime. The lack of a high energy early adjustment phase could be because this is on the downstream end of the sand body. Flow was to the east.

Plate 8

Plate 8A illustrates the uninterpreted sand peel sculpture 3 and **Plate 8B** shows sand peel sculpture 3 with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture8>.



Summary

Above the pre-Harvey deposit and maximum flood erosional surface, there is sediment deposited from suspension. This is topped by the channel cut erosional surface and the large channel cut deposit. Within the channel cut deposit, there is a thin mud layer that was deposited by a post-Harvey flood.

The base of peel 3 contains the pre-Harvey mud layer followed by an erosional surface. There is also a large scour cutting into the mud layer caused by rapid influx of sediment. Above this, there is some organic material and a layer of sand with no obvious sedimentary structures. This sand was likely sediment that was suspended in the water and fell out, indicating that there was so much suspended sediment in the water, it could no longer carry all of it. This layer of sediment deposited from suspension is followed by an erosional surface and a layer of organic material. This erosional surface was caused by the channel cut and it marks the start of the channel cut deposit. Above the organic material, there is a large section of trough cross bedding that was formed by dunes that are in the upper part of the lower flow regime. Above these dunes, there is a 3 cm (1.2 in) thick layer of mud that is rich in organic material, indicating rapid decrease in flow velocity. This mud layer occurred during a post-Harvey flood event, most likely early November. Above the mud layer, there are ripples, indicating an increase in velocity, however ripples are in the lower part of the lower flow regime. Moving up to the very top of the peel, the foreset laminae become concave. Concave foresets indicate a high flow velocity and high suspended sediment. These laminae are also banded by grain size that likely occurred because of grain fall. The red arrows indicate the flow direction.

Event Timing

Flood phase, August 28, 2017: Buffalo Bayou reached its maximum water level at about 1:00 am, with a measured gauge height of 15 m (41.90 ft). The rising water level leading up to August 28 meant a high energy system, causing erosion of the material that had already been deposited there prior to the flood. Erosion ceased and deposition began following the maximum gauge height as the water level began to drop. This is marked by the red line that outlines the erosional surface. Flow was to the east.

Early to middle adjustment phase, August 28–September 15, 2017: The flow energy in Buffalo Bayou was dropping during this time so deposition took place. A very high concentration of sediment was present in the water and was deposited out of suspension. Flow was to the east.

Late adjustment phase, October 1–November 29, 2017: The channel cut occurred during this time. On peel 3, these deposits are from the green line to the top of the peel. Flow was to the west.

Late adjustment thunderstorm, November 1–5, 2017: There was a smaller scale flood during this time and the gauge height reached 1 m (6 ft). The flood event was preserved in peel 3 as a thin mud layer.

Plate 9

Plate 9A illustrates the uninterpreted sand peel sculpture 4 and **Plate 9B** shows sand peel sculpture 4 with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture9>.



Summary

Above the pre-Harvey deposits and maximum flood erosional surface, there is sediment deposited from suspension. This is topped by the channel cut erosional surface and large channel cut deposit that contains dunes as well as thin mud layers, indicating varying flow energy.

The base of peel 4 is also the pre-Harvey mud layer followed by an erosional surface. There is a large scour pocket cutting into the mud layer. The scour is very steep, so it is likely that the mud below was only semi-consolidated. Above the mud layer, there is a thick package of sand that shows no clear sedimentary structures, so it was likely just sand that fell out of suspension because the amount of suspended sediment in the water was too great. Moving upsection from this, there is an erosional surface that was caused by the channel cut. The rest of the peel is channel cut deposit. Above the erosional surface, there is large scale trough cross stratification from dunes, this indicates medium flow velocity. However, there is a 1 cm thick layer of mud, as well as thinner mud layers throughout the dunes, indicating varying flow velocity that was high for the majority of the time of deposition but slowed down intermittently. The red arrows indicate the flow direction.

The west end of peel 4 and north end of peel 5 abut at a right angle creating a 3D corner view.

Event Timing

Flood phase, August 28, 2017: Buffalo Bayou reached its maximum water level at about 1:00 am, with a measured gauge height of 15 m (41.90 ft). The rising water level leading up to August 28 meant a high energy system, causing erosion of the material that had already been deposited there prior to the flood. Erosion ceased and deposition began following the maximum gauge height as the water level began to drop. This is marked by the red line that outlines the erosional surface. Flow was to the east.

Early to middle adjustment phase, August 28–September 15, 2017: The flow energy in Buffalo Bayou was dropping during this time so deposition took place. There was a very high concentration of sediment in the water and it was deposited out of suspension.

Late adjustment phase, October 1–November 29, 2017: The channel cut occurred during this time. On peel 4, these deposits are from the green line to the top of the peel. Flow was to the north

Plate 10

Plate 10A illustrates the uninterpreted sand peel sculpture 5 and **Plate 10B** shows sand peel sculpture 5 with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture10>.



Summary

Peel 5 starts out with the pre-Harvey mud deposit topped by the maximum flood erosional surface. Above this there is a high energy flow deposit, which contains antidunes. This is followed by the channel cut erosional surface and the rest of the peel is channel cut deposit. The channel cut deposit shows varying flow, starting in the lower flow regime with dunes followed by ripples and then transitioning into upper flow regime indicated by planar stratification and antidunes.

The base of peel 5 is a mud layer that was deposited pre-Harvey followed by an erosional surface. Above this erosional surface, there are antidunes that indicate high flow velocity and upper flow regime. Above the antidunes, there is some soft sediment deformation caused by a rapid influx of sediment. There is a transition from upper flow regime to lower flow regime separated by the channel cut erosional surface. Above the channel cut erosional surface there is a thick package of trough cross stratification from dunes, which are lower flow regime. Initially, the troughs are rich in organic material but then there is a transition to sand only. However, the

organic rich and sand rich troughs all occurred in the same event, so there was a change in the composition of the water from organic rich to organic poor. Within the dunes there are some clays deposited, indicating a varying flow, where the flow was relatively high for deposition of dunes, but it slowed down intermittently when the muds were deposited. Moving upsection there is a transition from dunes to ripples and some eddie ripples can be observed. This indicates a decrease in flow velocity, however the velocity is still varying, because there are mud drapes deposited within the ripples. Above these ripples, there is a transition from lower to upper flow regime, as planer stratification is observed followed by antidunes. This indicates very high velocities but low water depths. The red arrows indicate the flow direction.

The west end of peel 4 and north end of peel 5 abut at a right angle, creating a 3D corner view.

Event Timing

Flood phase, August 28, 2017: Buffalo Bayou reached its maximum water level at about 1:00 am, with a measured gauge height of 15 m (41.90 ft). The rising water level leading up to August 28 meant a high energy system, causing erosion of the material that had already been deposited there prior to the flood. Erosion ceased and deposition began following the maximum gauge height as the water level began to drop. This is marked by the red line that outlines the erosional surface. Flow was to the east.

Early adjustment phase, August 28–30, 2017: By the morning of the 28th through the 30th, the water level dropped rapidly and the flow conditions were in the upper flow regime. On peel 5, the sediment deposited during this time is from the red line to the green line. Flow was to the east.

Late adjustment phase, October 1–November 29, 2017: The channel cut occurred during this time. On peel 5, these deposits are from the green line to the top of the peel. Flow was to the north.

Plate 11

Plate 11A illustrates the uninterpreted sand peel sculpture 6 and **Plate 11B** shows sand peel sculpture 6 with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture11>.



Summary

Peel 6 starts with the pre-Harvey mud layer and maximum flood erosional surface. This is followed by a thick package of sediment that is deposited under high energy flow conditions. The channel cut erosional surface cuts into this and the rest of the peel is channel cut deposit.

The base of peel 6 is the pre-Harvey mud layer followed by an erosional surface. Above this erosional surface, there are no distinct sedimentary structures so this sand was likely deposited as suspended sediment that settled out of the water during a period of rapid velocity decrease. At the top of this package of sediment from suspension, there is planar bedding, indicating upper flow regime and increase in velocity. Above this, there is a channel cut erosional surface and some organic material. From this erosional surface to the top of the peel is a channel cut deposit, and the sedimentary structures indicate that it is a waning flow deposit. There is trough cross stratification from dunes, and at the top of the peel ripples can be observed. There is also a layer of mud above the ripples, indicating very low flow velocity. The red arrows indicate the flow direction.

Event Timing

Flood phase, August 28, 2017: Buffalo Bayou reached its maximum water level at about 1:00 am, with a measured gauge height of 15 m (41.90 ft). The rising water level leading up to August 28 meant a high energy system, causing erosion of the material that had already been deposited there prior to the flood. Erosion ceased and deposition began following the maximum gauge height as the water level began to drop. This is marked by the red line that outlines the erosional surface.

Early adjustment phase, August 28–30, 2017: By the morning of the 28th through the 30th, the water level dropped rapidly and the flow conditions were in the upper flow regime. On peel 6, the sediment deposited during this time is from the red line to the green line.

Late adjustment phase, October 1–November 29, 2017: The channel cut occurred during this time. On peel 6, these deposits are from the green line to the top of the peel. Flow was to the north.

Plate 12

Plate 12A illustrates the uninterpreted sand peel sculpture 2 and **Plate 12B** shows sand peel sculpture 2 with description and interpretation. The adjacent QR code provides a digital link to a high-resolution version at <https://flowarchive.com/hurricaneharvey/Sandpeelsculpture12>.



Summary

Above the erosional surface, upper flow regime bedforms are deposited as the river bar deposit followed by the channel cut erosional surface and the channel cut deposit. At the top of the peel, there are no sedimentary structures because the sediment was deposited by bulldozers.

At the base of peel 2, there is a mud layer with a large basal scour in it. This mud layer was pre-Harvey, and it is topped by an erosional surface. Above this erosional surface, there is planar bedding, indicating upper flow regime and high flow velocity. This is the river bar deposit. Above this there is a thin mud layer within the sand, followed by a large scour rich in organics. This marks the start of the channel cut deposit. Within the channel cut deposit, there is a thick package that has undergone soft sediment deformation. The soft sediment deformation was caused by a rapid influx of sediment on top of this package, causing compaction and pushing the water out, deforming the sediment. Moving up the section, there is a well-defined brecciated zone, where laminations were broken up and transported as a result of late channel collapse. Above the brecciated zone, there are gently climbing ripples that indicates a fast sedimentation rate and a high amount of suspended sediment. Above the ripples, there are no sedimentary structures, because this sand was deposited by a bulldozer during Hurricane Harvey recovery. The red arrows indicate the flow direction.

Event Timing

Flood phase, August 28, 2017: Buffalo Bayou reached its maximum water level at about 1:00 am, with a measured gauge height of 15 m (41.90 ft). The rising water level leading up to August 28 meant a high energy system, causing erosion of the material that had already been deposited there prior to the flood. Erosion ceased and deposition began following the maximum gauge height as the water level began to drop. This is marked by the red line that outlines the erosional surface. Flow was to the east.

Early adjustment phase, August 28–30, 2017: By the morning of the 28th through the 30th, the water level dropped rapidly and the flow conditions were in the upper flow regime. On peel

2, the sediment deposited during this time is from the red line to the green line. Flow was to the east.

Late adjustment phase, October 1–November 29, 2017: The channel cut occurred during this time. On peel 2, these deposits are from the green line to the blue line. Flow was to the north.

Recovery phase, November 30, 2017: As part of the Hurricane Harvey recovery effort, the city of Houston used bulldozers to transport mass amounts of sediment, which was then deposited in Buffalo Bayou. This deposit is from the blue line to the top of the peel. Flow was to the west.



Plate 1A. Sand peel sculpture 1.



Plate 1B. Sand peel sculpture 1. Description and interpretation.



Plate 2A. Sand peel sculpture A.



Plate 2B. Sand peel sculpture A. Description and interpretation.



Plate 3A. Sand peel sculpture B.



Plate 3B. Sand peel sculpture B. Description and interpretation.



Plate 4A. Sand peel sculpture C.



Plate 4B. Sand peel sculpture C. Description and interpretation.



Plate 5A. Sand peel sculpture D.



Plate 5B. Sand peel sculpture D. Description and interpretation.



Plate 6A. Sand peel sculpture E.



Plate 6B. Sand peel sculpture E. Description and interpretation.



Plate 7A. Sand peel sculpture X.



Plate 7B. Sand peel sculpture X. Description and interpretation.



Plate 8A. Sand peel sculpture 3.

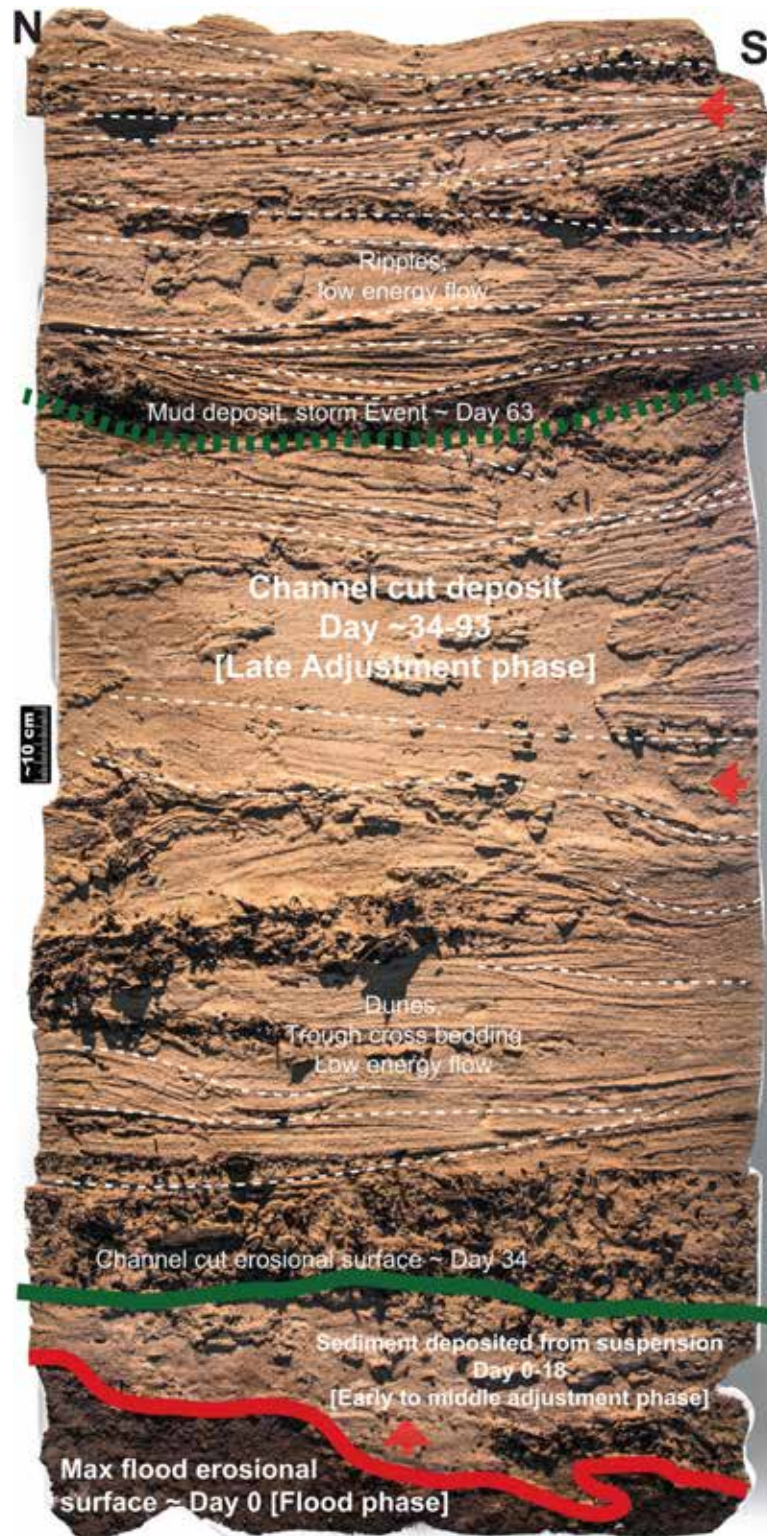


Plate 8B. Sand peel sculpture 3. Description and interpretation.



Plate 9A: Sand peel sculpture 4.

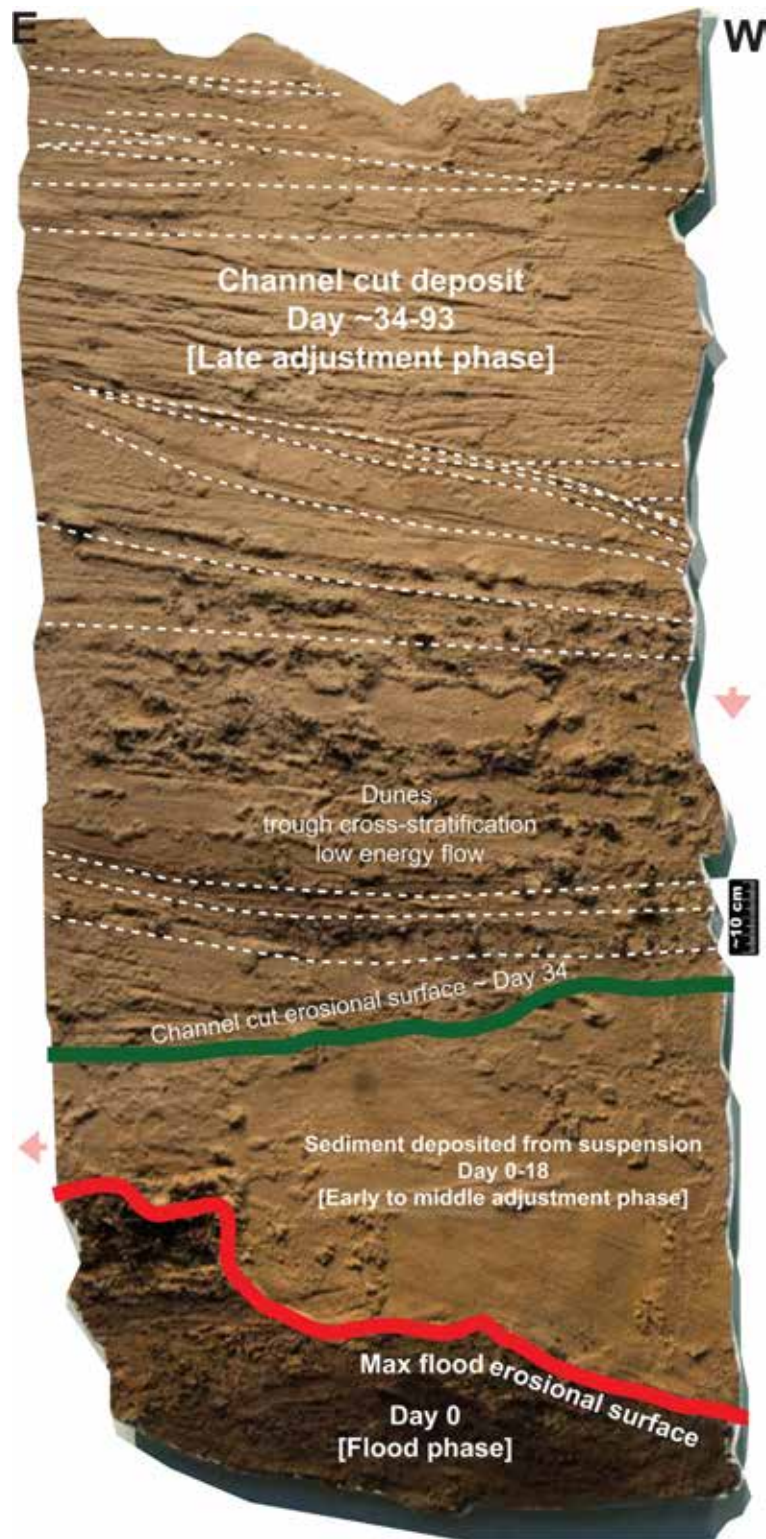


Plate 9B: Sand peel sculpture 4. Description and interpretation.



Plate 10A. Sand peel sculpture 5.

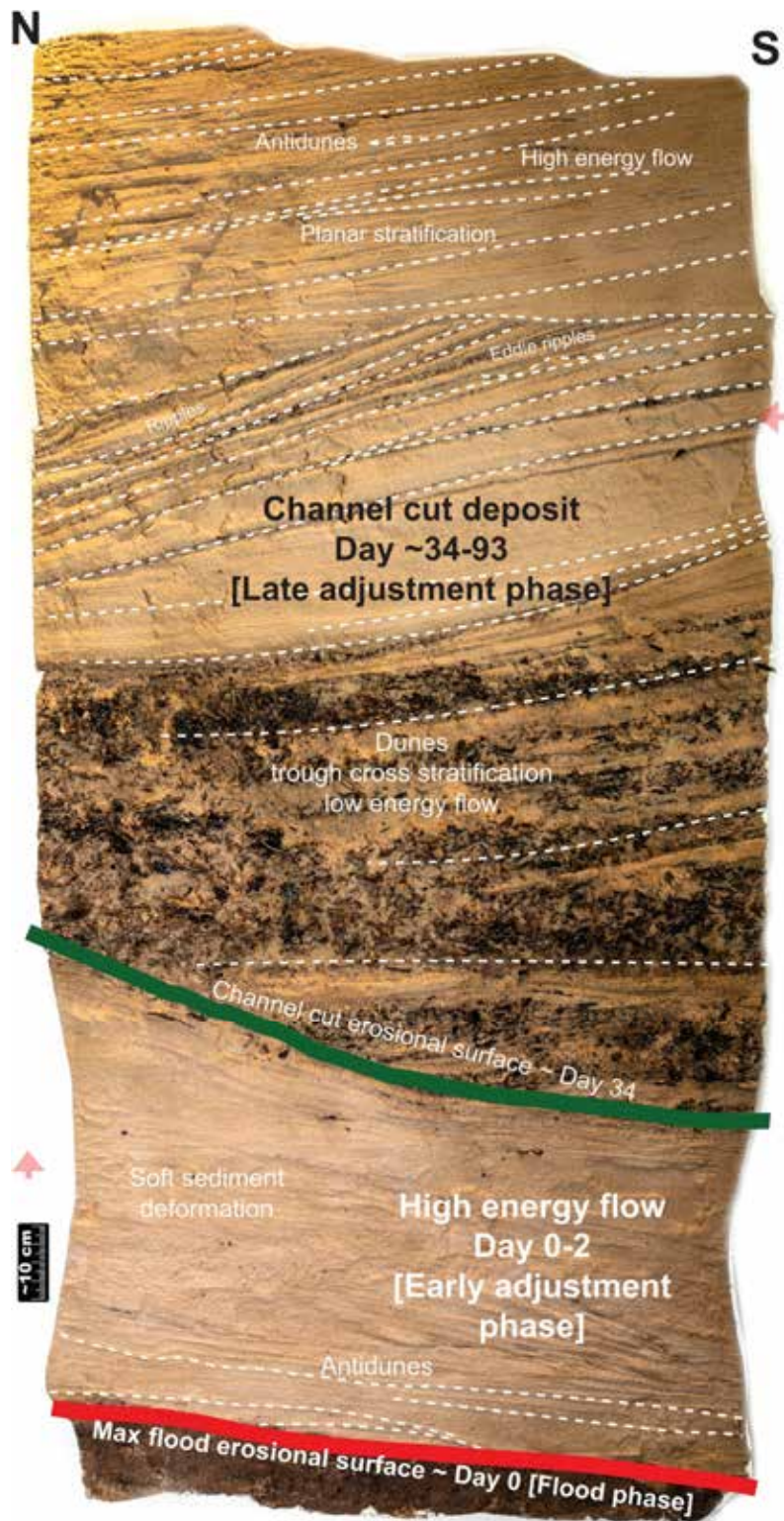


Plate 10B. Sand peel sculpture 5. Description and interpretation.



Plate 11A. Sand peel sculpture 6.

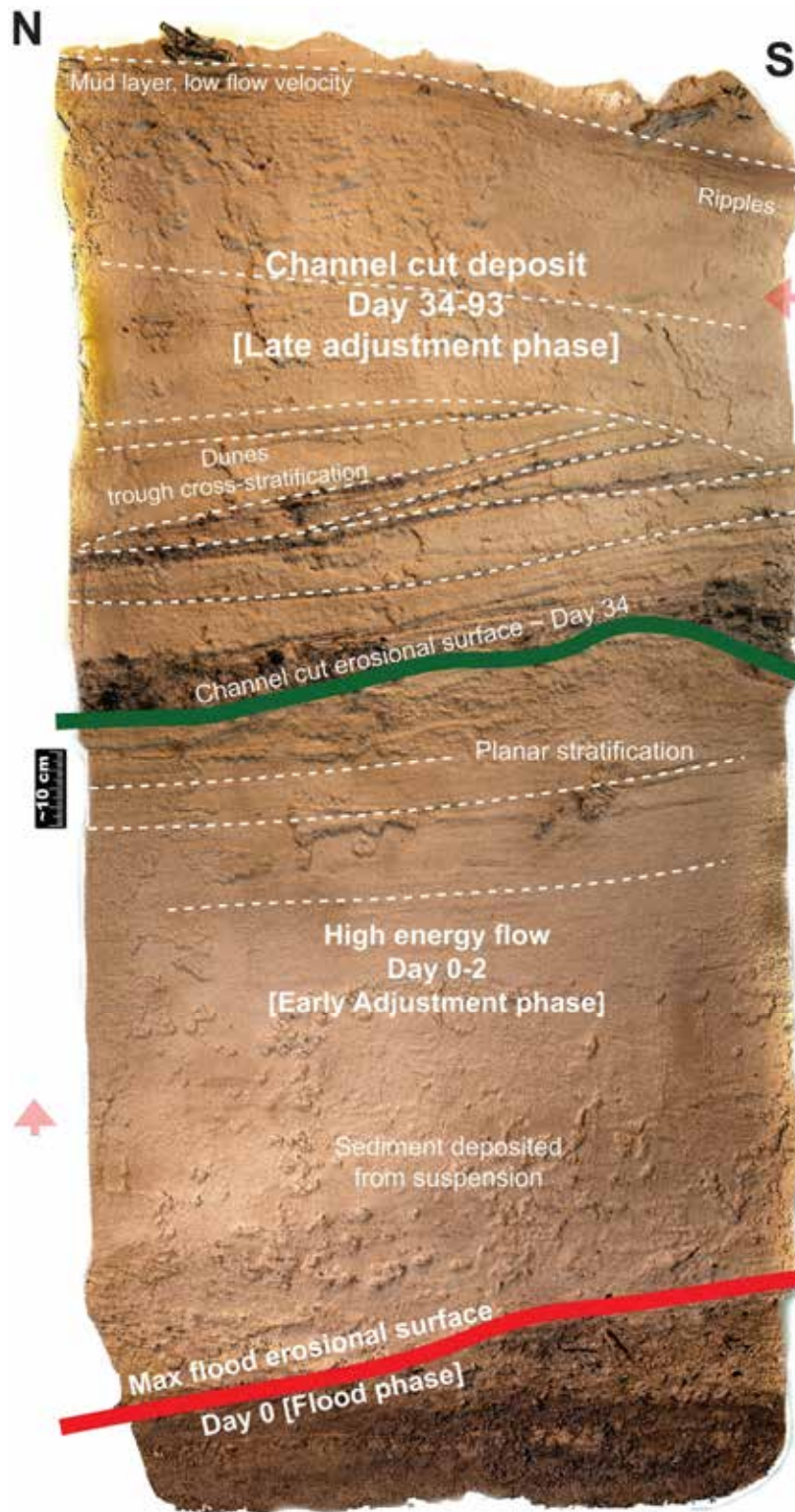


Plate11B. Sand peel sculpture 6. Description and interpretation.



Plate 12A. Sand peel sculpture 2.

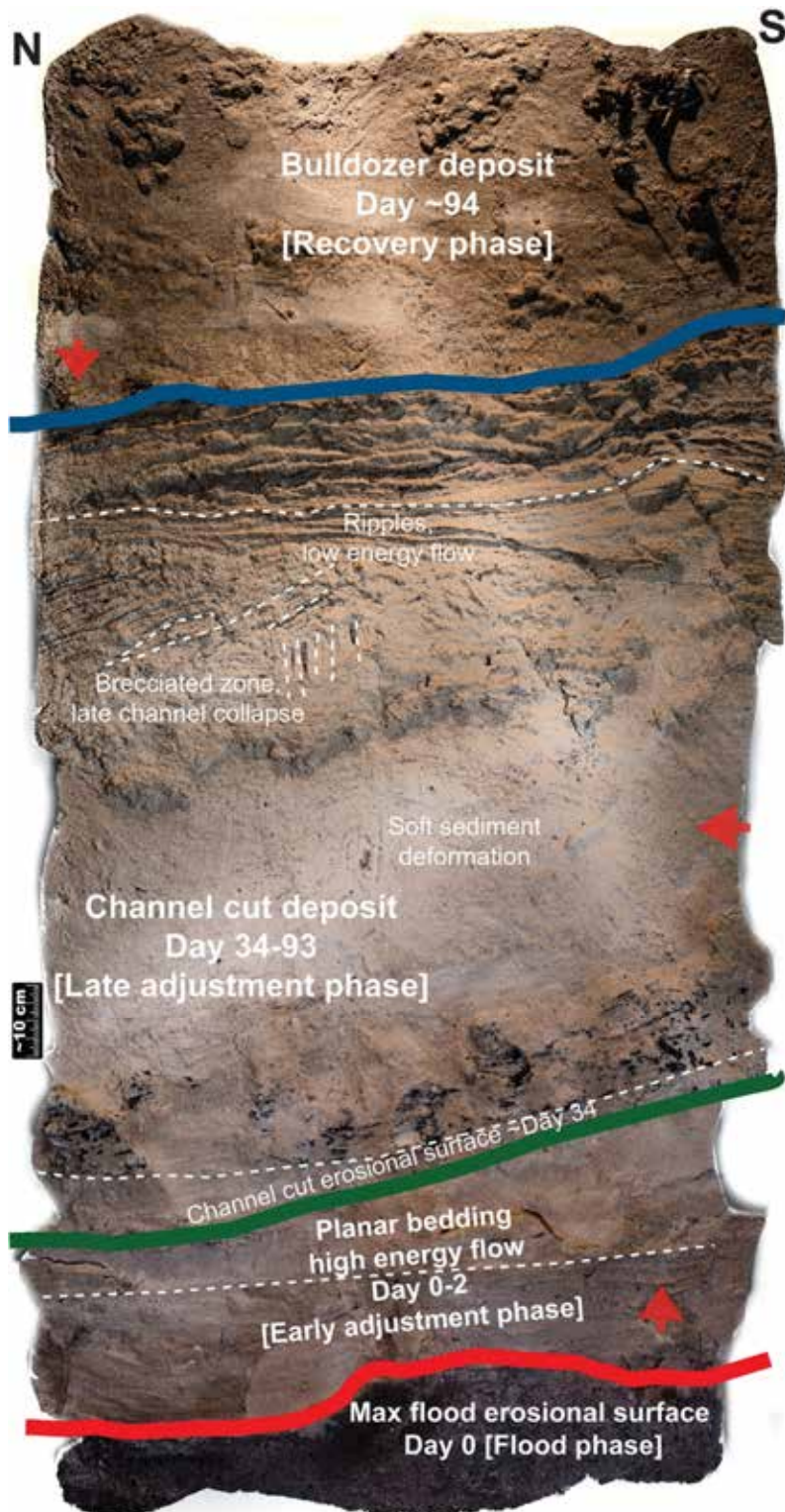


Plate 12B. Sand peel sculpture 2. Description and interpretation.

NOTES
