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Date: 11/14/2022

To whom it may concern:

The University of Texas at Austin is pleased to endorse the following proposal enclosed for your review.

Title of Application:	*Quantification and Correlation of Sediment Microplastics and Nutrients with Population Density in Lake Austin and Lady Bird Lake*	**OSP Number:**	FP00001662
Principal Investigator:	Marcy Davis, Ph.D.		
Project Total Costs:	$160,000	**Cost Share Amount:**	$0
DUNS:	170230239	**Cage Code:**	9B981
Project Dates:	01/01/2023 to 12/31/2024		

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AUTHORIZED OFFICIAL

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Enclosures:
Proposal Statement of Work
Budget
Budget Justification

University of Texas – Jackson School of Geosciences/City of Austin Quantification and Correlation of Sediment Microplastics and Nutrients with Population Density in Austin's Waterways: **Lake Austin and Lady Bird Lake**

Marcy Davis, Cornel Olariu, and Dan Duncan (Jackson School of Geosciences, The University of Texas at Austin), and Brent Bellinger (City of Austin Watershed Protection Department)

PROBLEM STATEMENT

Microplastics (MPs) pollution is one of Texas' greatest environmental concerns, and an issue that is receiving scientific attention (e.g., Microplastics Science Team) and community action (e.g., San Antonio Bay Estuarine Waterkeeper v. Formosa Plastics Corp.). Research on MPs in Texas' coastal areas is relatively robust; however, research on MPs freshwater systems is limited to a few studies (e.g., tributaries to Galveston Bay (USGS 2020), the Brazos River at Waco and San Marcos River at San Marcos (Peters and Bratton 2016; Stovall 2018); fishes from Texas' major watersheds (Phillips and Bonner 2015); the Lower Rio Grande Valley (Franklin, unpub.). The accumulation of MPs in Austin's waterways is a potentially significant issue given the amount of trash (mostly single-use plastics) in local waterways (Clamann et al. 2022) and the number or cars on the City's roads. To date though no quantification of MPs in the Austin region have been attempted.

Austin is the largest city within the Colorado River watershed and relies 100% on the Highland Lakes for municipal drinking water. Lake Austin and Lady Bird Lake also support urban subsistence fishers who rely on healthy bass, carp, and sunfish as an alternative food source. These reservoirs are the city's recreational focal points, and are imperative for generating hydroelectric power, for water conveyance during Colorado River basin flood events, and for providing downstream water to meet environmental flow requirements, and agricultural, municipal, and commercial demands. More than 10 tons of trash is removed just from Lady Bird Lake each year.

With Austin's population projected to double to more than 4.5 million by 2050, understanding the relationship between urbanization and MPs in the local environment is essential to ensuring good water quality and a healthy urban freshwater ecosystem for Austin and for downstream communities. Local academic–industry–government-non-profit collaborations are increasingly important for addressing aging reservoir infrastructure, water availability, and water quality.

We propose a two-year joint University of Texas-Jackson School of Geosciences(JSG)/City of Austin Watershed Protection Department research collaboration to quantify microplastic and sediment nutrient accumulation and migration paths in Lake Austin and Lady Bird Lake.

This study expands on the *University of Texas Institute for Geophysics (UTIG)-City of Austin Watershed Protection Department (COA-WPD) partnership to address sediment-driven eutrophication rates in Lake Austin and Lady Bird Lake* (ongoing) and the *UTIG-JSG-WPD Quantification and Correlation of Microplastics and Population Density in Austin's Waterways* set to begin in winter 2022-2023.

BACKGROUND

Microplastics

Microplastics (MPs; Arthur et al. 2009; **Figure 1**) are problematic pollutants, <5 mm in size, that increasingly pose great risk to environmental and human health. Like larger plastics, MPs are closely coupled to human activities and concentrated in urban areas (**Figure 2**), and may last for thousands of years in natural systems. MPs may be primary - manufactured as microscopic-scale plastics (e.g., beads found in personal care products, "nurdles"), or secondary - resulting from the breakdown of primary macroplastics (e.g., tires, synthetic textiles, fishing materials, consumer packaging) that are not included in the normal trash collection cycle (Barnes et al. 2009; Andrary 2011). A significant amount of MPs pollution is concentrated proximally to where MPs are created, especially in urban waterways and lakes.

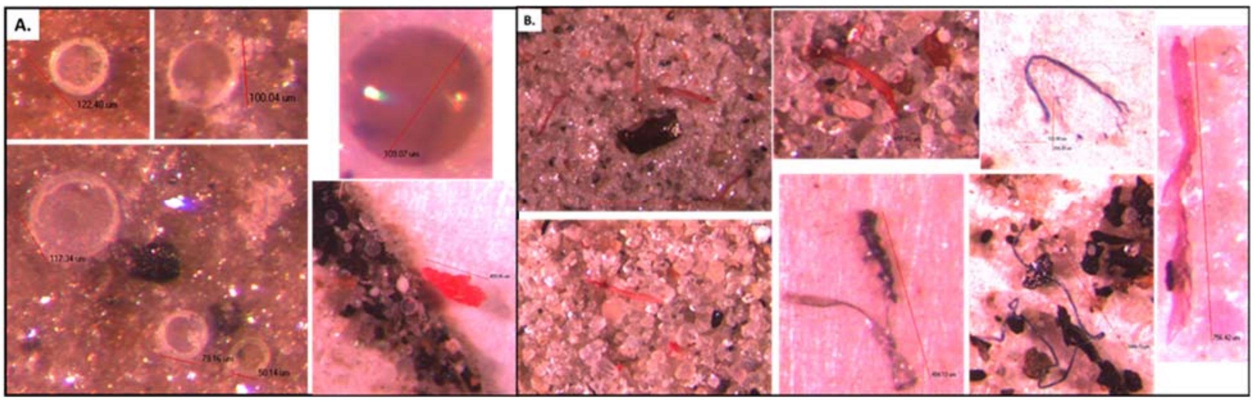

Figure 1. Microplastics from Matagorda Bay, Texas sediment samples A) Micro-disks, or possible nurdles, B) microfibers (photos: Will Bailey, JSG).

Urban freshwater systems are especially vulnerable to MP pollution due to high population density and human activities. Cities concentrate packaging, paint, transportation, electronics, and construction materials (**Figure 2A**; Qiu et al. 2020) which breakdown to form "city dust" that is spread through improper waste and wastewater management, and surface, storm water, and agricultural runoff. In Austin, we expect that atmospheric "city dust" and street/runoff litter are significant sources of microplastics as is tire rubber (**Figure 2B**) resulting from the high traffic load within the Colorado River watershed. Urban lakes and reservoirs, including Lake Austin and Lady Bird Lake, act as local sinks for various pollutants, including MPs. Additionally, rivers that flow through large metropolitan areas, like the Colorado River, are a major source for downstream and coastal MP pollution (Lin et al. 2018).

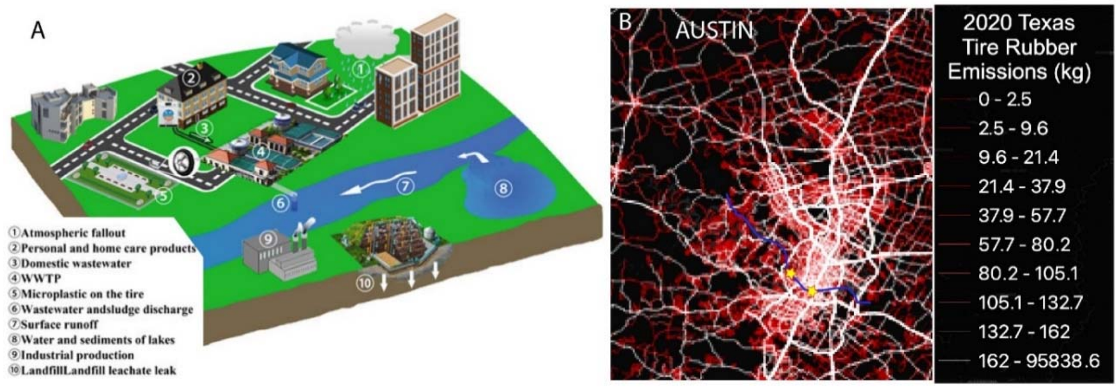

Figure 2. A) Microplastic sources in urban environments (from Qiu et al. 2021), B) Map of estimated tire rubber emissions (which are microplastics) in the Austin area (Olariu et al. in prep.).

MP research in the marine environment began in the early 2000s. The negative effects of MPs on marine organisms are well documented with most of these studies focused on coastal and marine systems as "ultimate dumps" for plastics (Andrady et al. 2011; Jambeck et al. 2015; Harris 2020); however, significant knowledge gaps concerning the impact of MPs on terrestrial and freshwater ecosystems remain. Similarly, studies that attempt to correlate population growth and/or other demographics and MP loads are largely in coastal areas where ocean current redistribution dampens spatial and temporal signals (e.g., Nel et al. 2016).

Recent studies reveal that MPs are widespread in freshwater ecosystems, but characterization of MPs abundance, prevalence, and type are generally lacking, especially for small stream and lake systems (Martins and Guilhermino 2018; Yang et al. 2018). Studies of MPs in rivers reveal the deleterious effects on various freshwater organisms and aquatic plants (e.g., duckweed and algae (Kalicikova et al. 2017), reeds (Yin et al. 2021)), and their tendency to adsorb toxic substances and support the colonization of pathogenic bacteria (Yang et al., 2022). MPs injure and block the digestive tracts of aquatic organisms, which may lead to starvation (Gamarro et al. 2020), and they accumulate contaminants from the surrounding environment, thereby acting as pollution vectors when digested by organisms (Bradney et al. 2019). Filter feeders (e.g., shrimps, oysters, mussels) are most affected (Smith et al. 2018), although MPs are also found in larger fauna, such as fish, which may confuse MPs with organic material suspended in the water column (Harris 2020) and mixed with organic food sources. Ingestion of MPs in place of organic matter can lead to consumer starvation.

MPs can potentially sicken humans by weakening immune and endocrine systems (Galloway, 2015). Van Cauwenberghe and Janssen (2014) estimate that humans with regular MPs exposure consume up to 11,000 MPs particles per year. For example, one person might ingest 50 MPs particles per day, on average, through seafood (Cox et al. 2019). Although not yet researched in detail, MPs may cause a range of medical problems in humans - their small size allows them to penetrate cell membranes and enter tissues (Lim 2021; Wright and Kelly 2017). MPs are in human feces, with higher concentrations in infant stool, which indicates that MPs are now ubiquitous in the environment and prevalent in food and beverages (e.g., sea salt, tap water, beer; Kosuth et al. 2018; Zhang et al. 2021). Leslie et al. (2022) documents MPs in human blood and emphasizes MPs' omnipresence.

Sediments and nutrients

Rapid urban development increases impervious cover within watersheds and results in greater runoff during rainfall events. Runoff negatively affects water quality and biological communities by fouling organisms that ingest pollutants, by biomagnifying metals and pollutants through the food web, and by promoting growth of nuisance plants and algae. Excessively polluted urban runoff waterway loading results in a decline in ecosystem services such as recreation, aesthetics, fishing, and provisioning of drinking water.

Rivers are natural conveyance pathways for organic and inorganic matter; however, impounded waterways, like Lake Austin and Lady Bird Lake, act as sinks for sediments and the nutrients and pollutants (e.g., heavy metals, carcinogens, and, increasingly, MPs) they carry (**Figure 3**). As sediments accumulate within a reservoir, desired ecosystem services are negatively impacted. For example, sediment accumulation reduces the total volume of a reservoir and, consequently, the amount of surface water available to a municipality and results in constant, expensive dredging operations to prolong reservoir life.

Sediment runoff (**Figure 3**) typically carries nutrients (e.g., nitrogen [N] and carbon [C]) utilized by microbial consumers and primary producers within aquatic environments. Carbon fuels microbial growth as it is transformed (organic C) or dissolves to a gaseous phase (e.g., carbon associated with carbonates). However, excess runoff due to watershed development or land use changes directly fuels nuisance plant and algal growth and production, thereby accelerating the "aging" of a waterway in a process called "cultural eutrophication". With eutrophication, water clarity typically declines, and potentially toxic cyanobacteria blooms can develop (Paerl et al. 2016; Wurtsbaugh et al. 2019; Gilbert 2020). Quantification of nutrient abundance in recent and older sediments aids in understanding how rapidly cultural eutrophication is occurring. Additionally, the isotopic composition of sediment carbon and nitrogen may provide insights as to the nutrient source (e.g., microbial decomposition, fertilizers, wastewater effluent) which could aid in targeted restoration and mitigation efforts within the watershed.

Austin recently experienced a drought of record (2009 – 2015), wherein basin inflows measured some of the lowest on record. Superimposed on and following the drought were several significant micro-droughts, multi-month periods of exceptionally dry weather. These droughts were coupled with above average temperatures that were punctuated by record rainfall and major flooding events (e.g., 2010, 2015, 2016, 2018, 2019) resulting largely from an increase in sea surface temperature anomalies in the Gulf of Mexico (NOAA/NWS/NCEP/EMC Marine Modeling and analysis) and a record number of named storms in the eastern Pacific Ocean (e.g. State Climatologist John Nielsen-Gammon, Austin American Statesman Jan 4, 2019). Heavy rain events that mobilize large volumes of sediment have been linked (e.g., Lake Erie) to the significant influx of nutrients that fuel planktonic harmful algal blooms (HAB) such as those that occurred in the Lady Bird Lake reservoir in 2019 and 2020. Some areas of the reservoir supported thick mats of filamentous green algae, which, although non-toxic, alter sediment-water interface nutrient dynamics, and their deposition and senescence on shorelines around the Great Lakes regions has been linked to bird deaths (avian botulism). Other areas of the reservoir supported the growth and proliferation of mixed cyanobacteria-green algae mats; a small subset of cyanobacteria species produce a potent neurotoxin that resulted in the deaths of several dogs in 2019 (Manning et al. 2020). Besides the current toxic cyanobacteria mats, Lady Bird Lake conditions are favorable for future HABs due to increasing temperatures, low/variable hydrologic flows, and eutrophic conditions, all of which could severely impact municipal and recreational reservoir water use.

Figure 3. The confluence of Barton Creek and Lady Bird Lake in October 2018 (Jeff Cohen, Moonshine Images, photo). Significant volumes of sediment entered the Travis, Austin, and Lady Bird reservoirs following historic rainfall and flooding in the Highland Lakes watershed. Nutrients carried by sediments may fuel harmful cyanobacterial development.

Previous and Current Work

Microplastics

Ongoing work on tire consumption and tire rubber MPs emissions on Texas roads (Olariu et al., in prep.) indicates that a single car emits an average of 0.116 g per kilometer traveled. Approximately 20% of tire weight is lost to consumption (road abrasion) which equates, on average, to 1.5-2 kg of MPs emitted from a single tire. Combined tire abrasion and traffic data indicate that tens to hundreds of kilograms of tire tuber MPs is emitted along some high-traffic routes. These data also suggest that approximately 6% of all Texas MPs is emitted on the roads in and around Austin. The fate of tire rubber MPs is not yet well understood; some material is incorporated into atmospheric “city dust”. We expect that over 20% of locally-emitted tire rubber MPs reaches Austin area creeks and lakes.

An MPs project in Matagorda Bay, funded by the *Matagorda Bay Mitigation Fund*, focuses on MPs content in bay sediments. The project scope aims to establish a “baseline” for MPs content and gain an understanding of MPs transport pathways into the bay. Initial measurements show that there is wide variability from a few to tens of MPs particles in 100g of bay sediments. MPs water column circulation, sedimentation, re-suspension, and long-term sedimentation trend within the bay is not well understood; however, Colorado River delta sediments is one of the hypothesized “hot spots” for MPs concentrations, along with area industry plants and the coastal barrier overwash zone.

This project will complement the projects discussed above as an important link in the “source-to-sink” transport pathway.

Geophysical surveys

Multibeam bathymetry sonar

The Lower Colorado River Authority (LCRA) and the Texas Water Development Board (TWDB) have completed bathymetric surveys of the Highland Lakes and both institutions make bathymetric products available on their websites. LCRA maps (available in .pdf format at maps.lcra.org) include low-resolution bathymetric contours and aerial imagery; however, no products for Lake Austin or Lady Bird Lake are available online.

The TWDB performs surveys of all Texas fresh surface water bodies as part of their reservoir volumetric survey program in which they calculate reservoir storage capacity, sedimentation levels, sedimentation rates, and projected water supply. In addition to a 200 kHz multibeam sonar, they utilize coring in conjunction with a CHIRP sub-bottom profiler to determine pre-impoundment surfaces. TWDB products include a report for each lake as well as elevation relief, contour, sediment thickness, depth range maps and ArcGIS Shapefiles (including for Lake Austin (e.g., **Figure 4**) and Lady Bird Lake). All products are available on the TWDB website. The most recent available survey was completed in 2008 with survey lines oriented perpendicular to river flow and 500' spacing. Following the 2008 survey, the TWDB recommended a lake re-survey every 10 years or following a major flood event.

UTIG periodically performs high-resolution surveys of parts of Lake Austin during instrumentation testing and training. These surveys are informal and data are not edited, corrected, or made publicly available; however, we are currently revisiting these surveys as a time-series dataset. The data set will be incorporated in the *UTIG-JSG/COA-WPD partnership to address sediment-driven eutrophication rates in Lake Austin and Lady Bird Lake*, a two-year project funded by COA-WPD. Additional project-specific surveys included September 2021 and February 2022 survey, of Lake Austin between Pennybacker Bridge and Commons Ford Ranch Metropolitan Park, an area of interest due to the presence of relatively large and potentially dynamic sediment bedforms (**Figure 4**, bottom). Repeat surveys will allow us to create surface difference maps that track sediment transport changes through time. Bedform analyses using BAMBI software will quantify bedform morphologies and yield detailed information about riverine and reservoir processes.

UTIG also performed a baseline, high-resolution multibeam bathymetry survey of Lady Bird Lake in February 2022. The survey focused on the area between I-35 and Red Bud Isle, an area of interest due to the presence of fanwort (cabomba) (**Figure 5**). With repeat surveys, multibeam sonar can help quantify cabomba and other submergent macrophyte growth and distribution in Lady Bird Lake throughout the year.

Figure 4. Comparison of processed multibeam bathymetry sonar surveys of Lake Austin near Commons Ford Ranch Metropolitan Park - screenshot of 2008 TWDB survey (top) and screenshot of high-resolution multibeam bathymetry of the same area surveyed by UTIG in September 2021 and again in February 2022 (bottom). Mapping bedform location, scale, distribution, and movement helps quantify sediment mass, nutrients, and microplastics transport within the river/reservoir system. Frame includes an approximately 2 km-wide area.

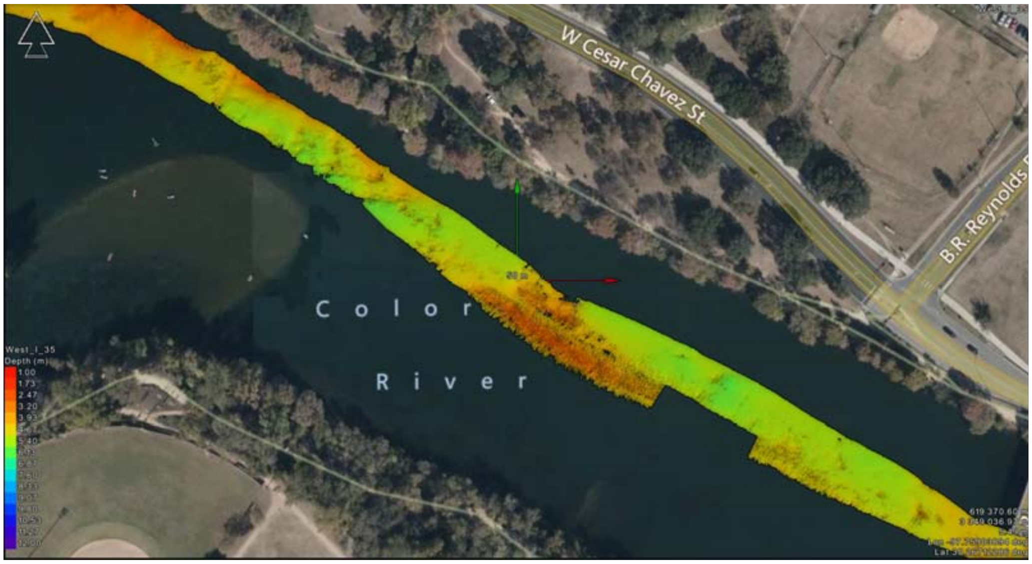

Figure 5. February 2022 high-resolution multibeam sonar survey at Barton Springs highlighting areas of prolific cabomba growth (warmer colors in image center) in Lady Bird Lake.

Sidescan sonar

Sidescan sonar produces an image of the river/lake bottom using sound. Color differences on the image result from differences in intensities of the returned sound signals. Sidescan is useful for mapping river/lake bottom geomorphology, benthic habitats, and surficial sedimentary texture.

As part of the *UTIG-JSG/COA-WPD partnership to address sediment-driven eutrophication rates in Lake Austin and Lady Bird Lake* project, UTIG-JSG performed sidescan sonar imaging in Lake Austin and Lady Bird Lake in September 2021 and February 2022. Sidescan sonar helps quantify sediment flux and transport within a reservoir by imaging lakebed shape, sediment type, and vegetation distribution (**Figure 6**).

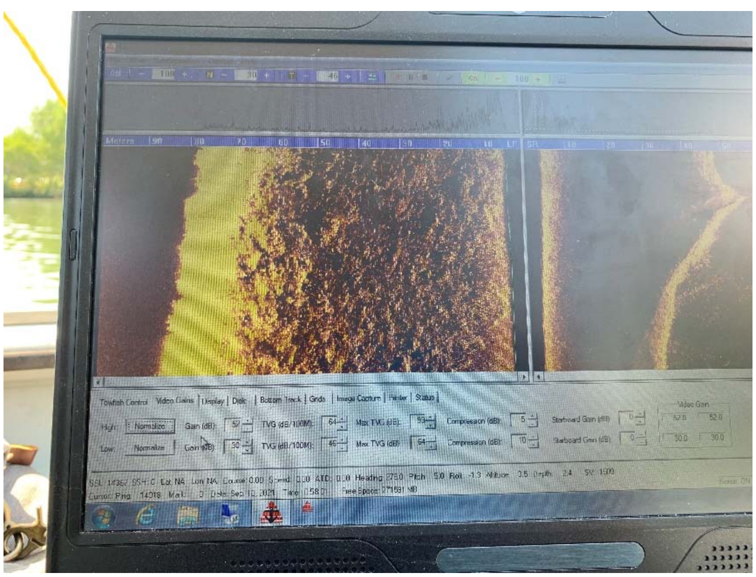

Figure 6. Sidescan sonar image of cabamba near Barton Springs in Lady Bird Lake.

Sediments

Direct sediment sampling methods, such as surface grab sampling (**Figure 7**) and coring help quantify grain size (i.e., clay, silt, sand, gravel) distribution (a measure of river energy), nutrient concentration, and MPs accumulation through time. Quantification and monitoring of sedimentation parameters in conjunction with MP and nutrient studies can inform remediation and policy efforts.

Grain size analysis (sieve and Mastersizer methods (<1 mm)) were performed on twenty-four sediment samples from Lake Austin and 6 sediment samples from Lady Bird Lake (sampled 09/21, 02/22, and 04/22). Analysis of results is pending.

Figure 7. Brent Bellinger (COA-WPD) takes a sediment grab sample on Lake Austin aboard UTIG's R/V Scott Petty using a petite-Ponar sediment sampler.

Nutrients

Sediment nutrient analysis (C, N content) using combustion elemental analysis (Costech 4010 EA) were performed on twenty-four samples from Lake Austin and six samples from Lady Bird Lake over multiple days from randomly selected sites in September of 2021 and March and April of 2022. Lake Austin sediments had an overall average C content of 13,690 mg/kg and N content of 1,088 mg/kg, with an average molar C:N ratio of 17. Lady Bird Lake average C contents were nearly 6x greater, at over 75,000 mg/kg, and N content was also 4x greater at an average of 4,500 mg/kg and a C:N ratio of 18. The next task will be to convert those units to mg/m^2 surface area to account for differences in grain sizes between the sites/reservoirs (Tolhurst et al. 2005). The δ^{13}C and δ^{15}N stable isotope composition from Lake Austin averaged -27‰ and 6‰, respectively. Lady Bird had a δ^{13}C of -30‰ and δ^{15}N of 4‰. These preliminary results reflect the contribution of carbon- and nitrogen- rich urban sediments to Lady Bird Lake compared with the runoff from the Hill Country landscape deposited in Lake Austin. The slightly lower C:N ratio of Lake Austin suggests that its organic matter is more decomposed. Additional data from each reservoir in addition to ^{13}C and ^{15}N isotopic data will help better elucidate decomposition trends and possible source(s) of the organic matter entering each reservoir.

PROJECT SCOPE

We propose a two-year study to 1) quantify MPs accumulation and migration paths in Lake Austin and Lady Bird Lake, including MPs flux along reservoir tributaries; and, 2) correlate nutrients (carbon and nitrogen) with seasonal creek discharge, lake conditions (water level, temperature, DO, pH), and MPs accumulation.

Location Details

The Colorado River of central Texas winds through more than 1,300 kilometers from its headwaters south of Lubbock to the Gulf of Mexico. The river flows southeasterly through the cities of Marble Falls, Austin, Bastrop, Smithville, La Grange, Columbus, Wharton, and Bay City to its outlet near Matagorda at Matagorda Bay.

Between 1843 and 1938, the Colorado River basin experienced 15 major floods that caused millions of dollars in damage. To help manage floods, the Lower Colorado River Authority (LCRA) built a series of six dams. These dams (Buchanan, Inks, Wirtz, Starke, Mansfield, and Tom Miller) created six fresh water lakes (together called the Highland Lakes - Buchanan, Inks, LBJ, Marble Falls, Travis, and Austin) (**Figure 7**). The City of Austin completed Longhorn Dam in 1960 and Austin Energy has always managed the dam. Longhorn dam created Lady Bird Lake, the seventh lake on the Colorado River, between Longhorn and Tom Miller dams, in downtown Austin.

Lake Austin

Lake Austin begins below Mansfield Dam, built 1937 to 1939 across a canyon at Marshall Long Ford, a long-established settlement and river crossing. The lake formed following construction of Tom Miller Dam in Austin in 1940. The lake is maintained as a constant-level lake by the release of water from Lake Travis. Two boat ramps at the Pennybacker Bridge and Walsh Boat Landing facilitate boating and fishing recreation. Several municipal parks provide public access to swimming and hiking trails along the lake shore. The lake has a maximum depth of approximately 18 m, an average depth of 3 m, and has a surface area of 1,600 acres.

A significant number of Lake Austin's tributary watersheds are undeveloped water protection lands, protected to preserve drinking water quality; however, the Lake Austin shoreline is highly developed with single-family homes, and the contributing reservoir of Lake Travis is experiencing significant suburban growth within its watershed. Large rain events deliver a sediment load to Lake Austin via Lake Travis discharge, or from Bull and Bee creeks, two primary tributaries.

Lady Bird Lake

Lady Bird Lake (previously Town Lake) begins below Tom Miller Dam and extends through downtown Austin to Longhorn Dam. The lake is the city's recreational focal point - municipal parks provide public access via a hike-and-bike trail and a couple of unimproved boat ramps. Several concessions provide SUP, kayak, canoe, and crew boat rentals. Lady Bird Lake depth averages approximately five m, a maximum depth of 10 m, and has a surface area of 416 acres.

Lake Austin delivers large sediment loads to Lady Bird Lake via Tom Miller Dam. Barton, Shoal, and Waller creeks can also contribute significant sediment loads. Dense, urban development, much of which is older than the reservoir, heavily impacts Lady Bird Lake and its tributaries (**Figure 8**).

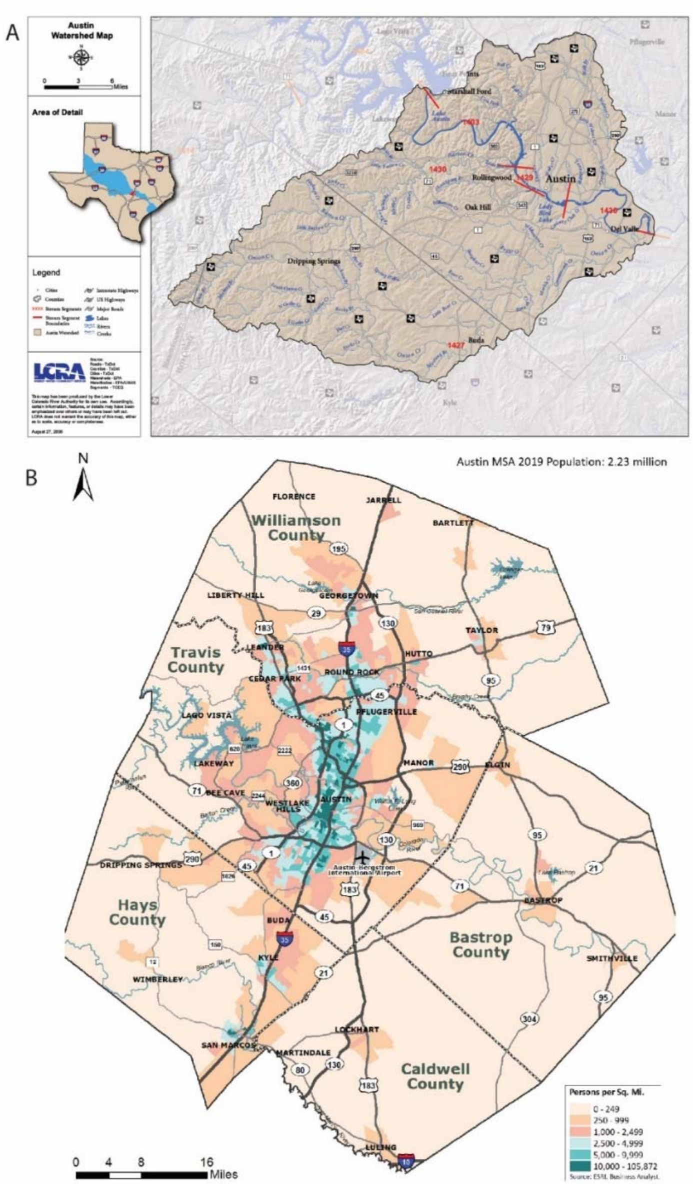

Figure 8. City of Austin A) watersheds (LCRA) and B) population density (Austin Chamber of Commerce). The city's highest population density is in the city center adjacent Lady Bird Lake and Lake Austin.

Hypotheses

We plan to test the following hypotheses:

1. The relationship between sediment nutrient levels and MPs discharged from tributaries is dependent on discharge volumes and the time between flood events (**Figure 9A**).
2. The amount of sediment nutrients and MPs in reservoir surface sediments increases toward dams (**Figure 9B**).
3. Sediment nutrients and MPs concentrations will be greater in Lady Bird Lake than in Lake Austin due to urban development and impervious cover in the tributary watersheds of the former.
4. Surface sediments will have higher MPs and nutrient concentrations relative to older sediments due to local urban growth and development through time (**Figure 9C**).

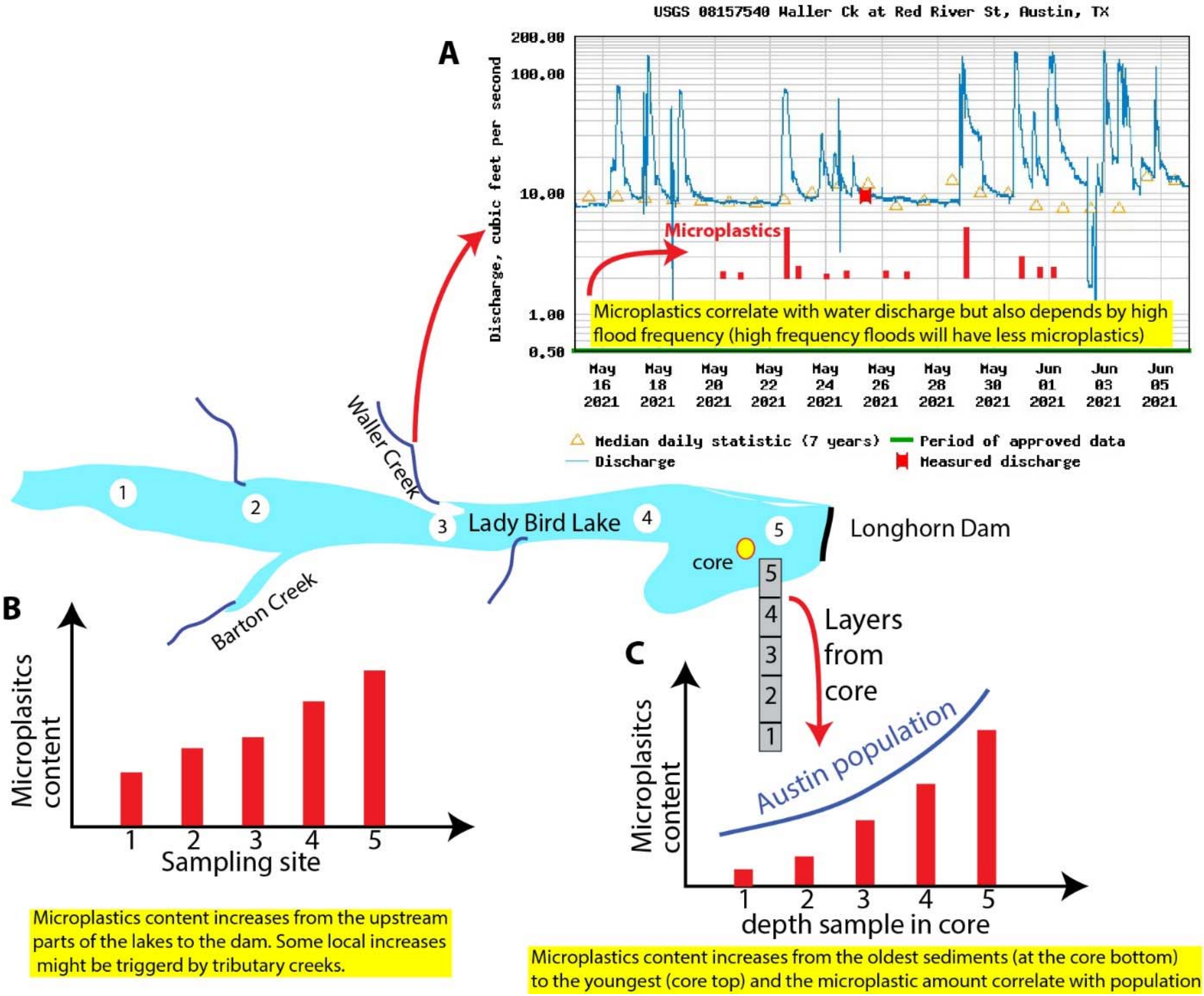

Figure 9. Schematic illustrating microplastics content hypotheses in Austin lakes. A) More microplastics are transported at the onset of low frequency (rare) flood events; B) Microplastics concentrations increases toward dams; and, C) Microplastics concentrations in the lake sedimentary record correlate to population growth.

Project goals

The following project goals will allow us to address each of the afore-mentioned hypotheses:

- Quantify MPs in Austin's reservoir sediments to understand the MPs sediment flux from tributaries through time. Sediment and core samples will be analyzed for MPs content using a density separation method (Nakajima et al. 2019).
- Investigate MP distribution (e.g., do MPs preferentially accumulate above dams or in deeper areas of the lakes?).
- Correlate water discharge and flooding events/seasonality to MPs accumulation in the lakes.
- Investigate whether MP accumulation is correlative to recent population growth.
- Investigate the localized effects of land use and human activity related to high-traffic recreational sites and land use (e.g., is there greater MP accumulation/flux during summer with more people enjoying waterfront parks?).

- Characterize MPs by form and color, both of which yield information about plastic type - critical to future study, mitigation, and abatement.

Methodology

Geophysical surveys

Multibeam bathymetry sonar

We will perform multibeam bathymetry surveys of the area west of Pennybacker Bridge between Ski Shores and Commons Ford Ranch Metropolitan Park twice a year. These surveys will provide information about seasonal differences (summer and winter) in sediment bedforms and sediment transport in Lake Austin. We will also perform a survey of Lady Bird Lake in Year 2 for comparison to a 2022 survey to gauge changes aquatic plant (cabomba) growth and distribution. These data will be considered with data acquired from the same location during informal UTIG surveys (equipment testing) and with data collected during the *UTIG-JSG/COA-WPD partnership to address sediment-driven eutrophication rates in Lake Austin and Lady Bird Lake* project. Repeat surveys will allow us to create surface difference maps that track sediment transport changes through time. Bedform analyses using BAMBI software will quantify bedform morphologies and yield detailed information about riverine and reservoir processes.

Sidescan sonar

We will perform sidescan surveys of Lake Austin west of Pennybacker Bridge between Ski Shores and Commons Ford Ranch Metropolitan Park and in Lady Bird Lake twice a year to evaluate cabomba growth and distribution in the lakes throughout the year. These surveys will be compared to sidescan sonar imaging in Lake Austin and Lady Bird Lake that occurred in September 2021 and February 2022 as part of the *UTIG-JSG/COA-WPD partnership to address sediment-driven eutrophication rates in Lake Austin and Lady Bird Lake* project. Sidescan sonar also helps quantify sediment flux and transport within a reservoir by imaging lakebed shape, sediment type, and vegetation distribution (**Figure 6**).

CHIRP sub-bottom profiler

We will perform a CHIRP sub-bottom profiler survey prior to coring above Mansfield, Tom Miller, and Longhorn dams. CHIRP operates with a swept frequency range, which enables high-resolution mapping of relatively shallow deposits (**Figure 10**). The survey will allow us to identify the best locations at which to take cores (where we can obtain the longest record). CHIRP will also assist with estimates of sedimentation rates near the dam.

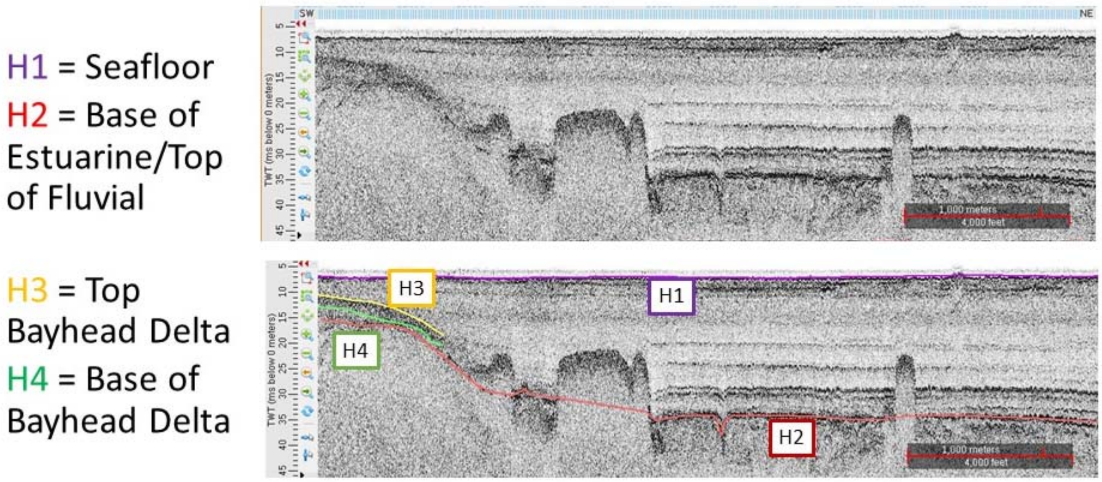

Figure 10. Example of processed and interpreted CHIRP data from Corpus Christi Bay in 2021 (UTIG MG&G Field Course, Team 4 Final Presentation). CHIRP operates with a swept frequency range, which enables high-resolution mapping of relatively shallow deposits.

Sediment sampling

We will collect surface (5-10 cm) sediment grab samples triennially, using a petite-ponar grab sampler (Figure 7), for two years to evaluate spatial and temporal (seasonal) variability of MPS and nutrient flux in consideration with land use (public vs. private) at 1) the heads and mouths of major tributaries to Lake Austin and Lady Bird Lake (tributaries are the interface between where plastic is used and tributary drainage networks); and, 2) above and below water treatment plants, major public recreation areas (e.g., Commons Ford Ranch and Emma Long metropolitan parks, Zilker Park, boat launches), Mansfield, Tom Miller, and Longhorn dams. These data may aid in identification of the most significant microplastics sources and travel pathways and subsequently used for mitigation efforts.

We will also collect sediment cores, using a small gravity corer, from above Mansfield, Tom Miller, and Longhorn dams to sample sediment changes and MPs accumulation through time. Sediment core data will provide temporal MPs accumulation data that likely correlates with Austin's population increase. If this is the case, together with direct measurement MPs flux, we can build a model to predict future potential MPs accumulation relative to projected population increases. Sediment cores will also help determine the sedimentation rates near the dams, important for understanding/predicting water volume changes over time.

Sediment analyses

Sediment grain size

Sediment grain size on grab and core samples will be done using a filter and sieve method and using a Mastersizer at the Jackson School's sediment laboratory. Data will highlight lake sediment distribution and transport pathways and likely correlate to MPs distribution and accumulation.

Nutrients and isotopic signatures

The top 5 cm of the grab sample sediments will be split for grain size analysis, and determination of total organic carbon after removal of inorganic carbon (e.g., limestone), total nitrogen, and $\delta^{13}C$ and $\delta^{15}N$ composition. Analyses will be run at the Jackson School's ion chromatography laboratory.

Samples will be dried, homogenized, and weighed into tin and silver capsules. Samples for organic carbon analyses will then be acid fumigated with hydrochloric acid to remove expected carbonates. Samples will then be combusted through an elemental analyzer (Costech 4010 EA) and analyzed using isotope ratio mass spectrometry (Thermo Finnigan Delta-V; EA/IRMS) for determination of nutrient contents and $\delta^{13}C$ and $\delta^{15}N$ isotopic compositions. We expect to analyze approximately 100 samples (70/30 between Lake Austin and Lady Bird).

Microplastics

Seasonal sediment sampling along tributary lower reaches and creek mouths into the lakes will provide information about the temporal and spatial variability of MPs and nutrient flux. These data may aid in identification of the most significant microplastics sources and travel pathways and subsequently used for mitigation efforts.

Core and grab sampleswill be tested for MP content in the Jackson School's sediment laboratory using a density separation method that has been effective for separating MPS from Texas' coastal bays and modified for the lakes' high organic content (Masura et al. 2015). We will also characterize MPs by form and color, both of which yield information about plastic type, which is critical to future study, mitigation, and abatement.

Deliverables

We will summarize this study's fieldwork, analyses, and results in a report to the City of Austin. The report will include raw data, summary maps, and our findings. In addition, we will make raw and processed data and maps and associated files available digitally.

The team will publish scientific findings in peer-reviewed scientific journals and present findings at scientific meetings as relevant.

Project timeline & estimated costs

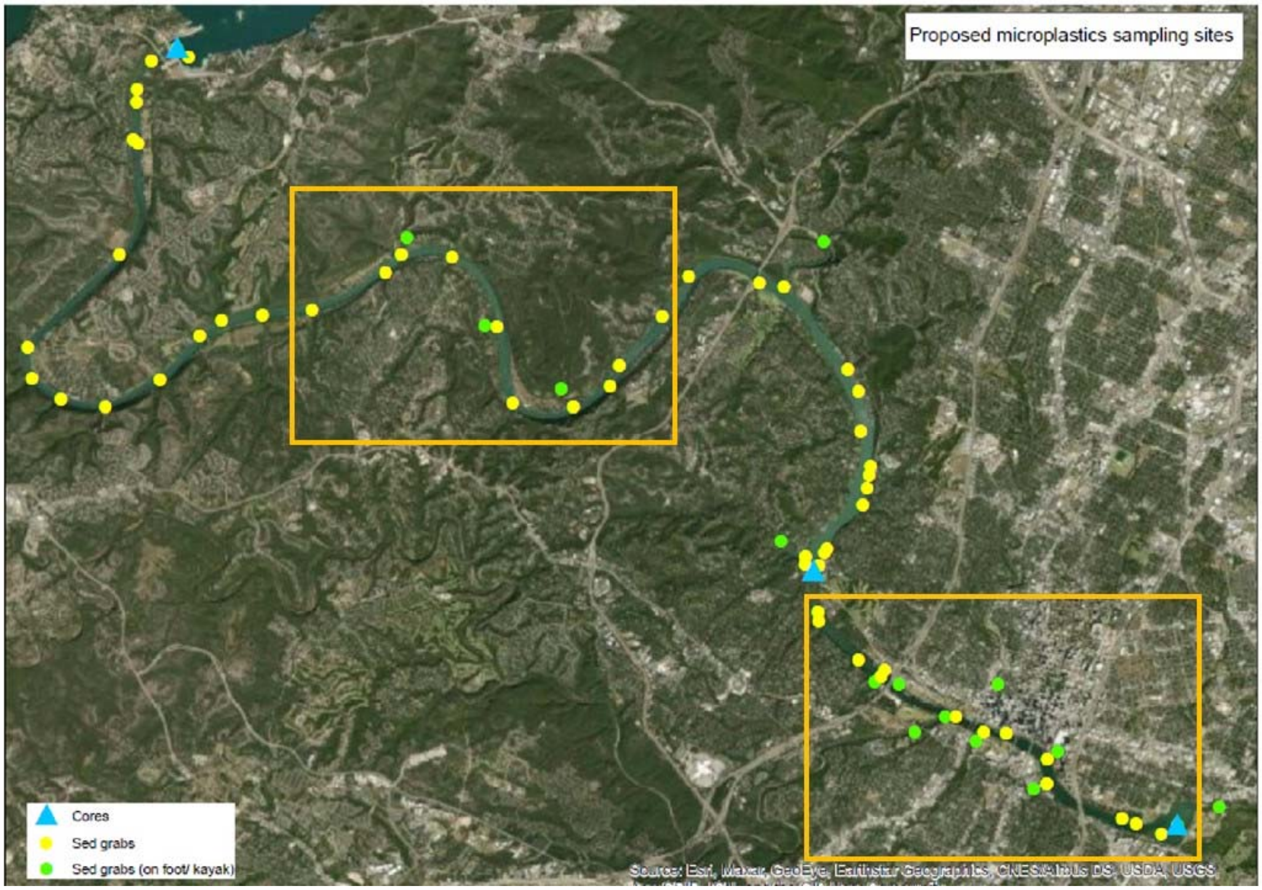

Figure 11. Proposed survey and sample locations in Lady Bird Lake and Lake Austin. Orange boxes outline geophysical survey areas.

We estimate that the two-year research project materials, supplies, equipment time, and sample analyses will cost $160,000. Details of the budget are available in Section 5 of UT Austin's Scope of Work.

*Note that UTIG-JSG internal funds ($25K) will support use of UTIG-JSG's research vessel, the *R/V Scott Petty,* and associated technical personnel through the Blue Sky *Research Innovation Program*.

This study also builds on the 2021-2023 UTIG-JSG Blue Sky (internal funds) *Research Innovation: UTIG-City of Austin Watershed Protection Department partnership to address sediment-driven eutrophication rates in Lake Austin and Lady Bird Lake, Austin, Texas* (Davis, Duncan, and Bellinger), and *Microplastic concentration in sediments and waters of Matagorda and San Antonio Bays: Initial assessment and mitigation plans* (Olariu).

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Quantification and Correlation of Sediment Microplastics and Nutrients with Population Density in Lake Austin and Lady Bird Lake

01 January 2023 through 31 December 2024

	Year 1	Year 2	Total
SENIOR PERSONNEL	*Months*	*Months*	
Davis, Marcy B - Eng Sci	1.25	1.25	2.50
Olariu, Cornel - Research Scientist	1.25	1.25	2.50
OTHER PERSONNEL			
Duncan, Daniel D - Eng Sci	1.00	1.00	2.00
Graduate Research Assistants (1)	2.25	2.25	4.50
Undergraduate Research Assistants (1)	1.00	1.00	2.00
Salaries and Wages	**43,347**	**44,647**	**87,994**
Fringe Benefits	**12,194**	**12,767**	**24,961**
TOTAL LABOR COSTS	**55,541**	**57,414**	**112,955**
OTHER DIRECT COSTS			
Materials and Supplies			
Expendable Materials and Supplies	96	141	237
Computer Services	1,500	1,500	3,000
Other			
Tuition	5,181	5,386	10,567
Lab Analysis Costs (@ $20/sample)	1,800	2,200	4,000
Edgetech CHIRP System	1,731	0	1,731
Multibeam Bathymetric Systems	2,376	1,584	3,960
Sidescan System	1,340	1,340	2,680
Total Other Direct Costs	**14,024**	**12,151**	**26,175**
TOTAL DIRECT COSTS	**69,565**	**69,565**	**139,130**
UT F&A COSTS (15.%)	**10,435**	**10,435**	**20,870**
TOTAL COSTS	**80,000**	**80,000**	**160,000**

BUDGET JUSTIFICATION

The budget includes staff support costs for 1.25 staff month each for senior personnel Marcy Davis and Cornel Olariou, 1.0 staff month for Engineering Scientist Dan Duncan, and 1 semester of support for a Graduate Research Assistant (includes tuition) and an Undergraduate Research Assistant. All participants will assist with fieldwork, analyses, and write-up.

Support is also requested for equipment usage fees, consisting of 3 days of CHIRP use at $577/day ($1,731), 3 days of multibeam sonar use at $792/day ($2,376), and 4 days of sidescan use at $335/day ($1,340). Additionally, the budget includes modest lab analysis costs estimated at $20/sample.

Finally, the budget includes 15% UT Facilities and Administrative cost applied to Total Direct Costs per UT’s negotiated agreement with City of Austin.