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# Apollo Auto-Visual Monitoring

## *A pilot program with collaboration between the City of Buckeye Public Works and the Arizona Department of Environmental Quality*

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A collaboration between the State of Arizona Department of Environmental Quality (ADEQ) and the City of Buckeye Public Works Department was designed to develop and enhance the outfall monitoring requirement of the municipal stormwater permit. This auto-visual outfall monitoring pilot program is named "Apollo."

Arizona Small Municipal Separate Storm Sewer System (MS4) Permit #AZG2016-002, section 6.4.3.8(b), *Visual Monitoring,* allows an alternative practice of visual discharge outfall monitoring. ADEQ proposed testing an alternative method allowing frequent, repetitive, and automated documentation via programmed photography. Buckeye volunteered to test this monitoring method—a first in Arizona!

With the addition of programmed photography, ADEQ proposed the municipality would be able to monitor an area for up to half-hour intervals in an attempt to observe the first flush discharge.

In addition to and separate from the auto-visual monitoring during wet weather, Buckeye used this opportunity to capture visual assessments of wildlife variety, potential effects of neighborhood irrigation runoff, and detection of illegal dumping.

ADEQ loaned Buckeye a digital game camera equipped with a locked, metal covering to deter tampering and theft. The camera was programmed with various settings which were tested and modified based on weather conditions.

Apollo focused on an outlet located in the Verrado neighborhood subdivision. Verrado is located within the east-central portion of Buckeye, a city in the Phoenix metropolitan region of Maricopa County, in the Sonoran Desert of the southwestern United States. Verrado consists of approximately 3,200 residential homes and 60-plus non-residential properties encompassing 3.5 square miles covering approximately 2,247 acres.

The sub-watershed, outlet, and wash are a general representation of similar features throughout Buckeye. Within Verrado, each outlet was scrutinized for this project and many had negative constraints ranging from being too close to homes and walkways, to over-vegetated areas or areas too difficult to access.

A location to mount the camera which provided ease of access, direct discharge to a wash, low profile area masking visibility from neighboring properties, and distance from walkways was chosen. The location had safe street parking, as frequent site visits were important to retrieve data and monitor equipment.

Historic rainfall data states the Sonoran Desert averages 24 rain events/year measuring ½" or less and experiences an average annual rainfall of 8". During FY18, the region continued to experience a multi-decade drought. Total number of rain events with a threshold of .01" of measurable rainfall or greater was 16; accumulating a rainfall total of 4½".

The camera was placed landward of the wash in an area not requiring a 404 permit from the U.S. Army Corps of Engineers or a 401 permit from ADEQ.

Buckeye utilized various weather sources to forecast precipitation opportunities. On dry days, photo controls were set at various options to gauge effectiveness of capturing data. When rain was forecasted, photo capture options were set to an increased frequency.

The camera's various date/time stamp, photo quality, fast flash, temperature, motion detection and time lapse features were each tested to determine efficiency.

## Findings

This collaboration allowed the city to capture much more data than a staff member could have the possibility of collecting from routine site visits. Photos showed discharge flow patterns using both interval and motion-detection testing.

This outlet receives frequent, daily irrigation runoff with flows reaching 5', 10', and 15' distance marks beyond the end of the outlet. (Flows beyond 25' actually enter the wash.) During measurable rainfall events where runoff entered the wash, flow patterns indicated some instances of significant foaming. Very little trash was observed, and turbidity was unable to be detected. Most flows were slow, low volume, taking up small portions of the discharge area outlet apron with unknown duration which made it unable to determine the volume of discharge or capture the first flush.

The camera set-up was not at the best angle to capture discharges from the outlet and wash. The angle of the sunlight negatively affected the photos. Heavy shadows falling during late afternoon obscured many photos. Future monitoring events include modifying camera angles, updating photo direction, and improved technology.

While this method of camera use and placement did not achieve the desired result of obtaining the first flush, other placement areas of the camera, and integration of a more sensitive camera with higher technology, will improve the permit-required method of data collection. Missing information included:

- Soil percolation rates
- Flow rate over time
- Beginning/end time of flows

Daily water discharge to this outlet during non-rain events was found to be from the irrigation system of individual neighborhood homes and common areas.

Foam of unknown origin and content was observed during several rain events and would not have been discovered without the camera capturing live flow events. Possible sources of foam could include organic detritus from heavily watered and maintained lawns and flower beds.

Capturing data through photographs saved staff from physically monitoring 16 rainfall events equating to a labor and equipment expense savings of approximately 64 hours or between $2,000-$4,000 in resource costs.*

## Positive Outcomes

Photo documentation included rain events, irrigation flow, dry weather events, and wildlife.

- Qualitative flow analysis
- Bulk material/trash deposits


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- Irrigation flow documentation
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- Monitoring areas difficult or costly to access
- Wonderful collaboration project between state and local government
- Development of an auto-monitoring process for MS4s
- Well over 10,000 photos were captured

### Wildlife:

- Coyote
- Dog
- Rabbit
- Ground Squirrel
- Rattlesnake
- Quail
- Dove
- Owl
- Bobcat
- Javelina
- Rats
- Deer
- Chipmunk
- Roadrunner
- Cougar

### Drainage Infrastructure

Buckeye's forward thinking ensured all new storm sewer systems discharge to private basins. Buckeye had 90% of its 25,000-plus homes built after 2000. Urban development throughout the Sonoran Desert historically doesn't have many direct discharges to WOTUS. The irrigation management, first developed by the Hohokam people, 1450 AD, rerouted runoff to farmlands and created sealed basins which never discharge.

A major challenge for a municipality is to map its entire stormwater infrastructure system to determine if an MS4 exists. Most storm systems in Buckeye consist of dry wells and no overflow structures. "The desert is an exciting place to put stormwater science and environmental health into practice," says Robert van den Akker, Environmental Manager for Buckeye's Public Works Department, "and we're going in the right direction to ensure we protect our citizens and the environment from pollution."

Foam of unknown origin and content was observed during several rain events and would not have been discovered without the camera capturing live flow events.

Auto-visual monitoring enabled staff to capture routine irrigation runoff, loose trash, qualitative discharges, and wildlife populations.

### Summary

Because absence of natural light, photos lacking density and perception, as well as turbidity and color not being observable, the city does not recommend a single camera placement method for use to capture visual assessments of a first flush. To help combat the issue of photo densities, plans are in place to reconfigure the monitoring area using two cameras. Many rainfall events occurred during late night/early morning when natural light wasn't present. Auto-visual monitoring enabled staff to capture routine irrigation runoff, loose trash, qualitative discharges, and wildlife populations. Staff identified possible waste, erosion, and sedimentation control issues, and added knowledge on necessary efforts to stop or identify sources of pollution discharging from the community.

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* Resource costs calculation includes a summation of staff and equipment usage for the 16 forecasted rain events, the mid-range average Environmental Compliance officer salary, $2 per hour on-call costs during non-operating hours (per city policy), and a 4-hour minimum work time, per event, to obtain necessary equipment and wait for potential rain events to occur.