

A PICTURE IS WORTH A THOUSAND WORDS: USING WIRELESS VIDEO CAMERAS TO SUBCATEGORIZE RECREATIONAL USE DESIGNATIONS

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Abstract: Wireless video cameras were installed in nine storm water channels to evaluate the potential for water contact recreation to occur in these locations. Cameras were programmed to collect one image every 15 minutes during daylight hours for twelve months. The resulting pictures were used as part of a Use Attainability Analysis to demonstrate that either no or only incidental, infrequent and partial body contact was occurring with no significant risk of immersion or ingestion. As a result, the associated stream segments are being recommended for reclassification which will result in the application of less stringent bacteria water quality criteria.

Keywords: bacteria, pathogens, Use Attainability Analysis, stormwater, TMDL

INTRODUCTION

By law, all surface waters of the U.S. are assumed to support full-body contact recreation unless the state performs a formal Use-Attainability Analysis (UAA) to prove otherwise. Waters designated for human recreation must comply with EPA's recommended water quality criteria for bacteria. Unfortunately, many streams, particularly in urban areas, do not meet these standards and have been added to the 303(d) list of impaired waterbodies. States are required to develop, and in a number of cases have already completed a TMDL and an implementation strategy to assure water quality standards are attained.

Because bacteria are ubiquitous in the natural environment, the cost and complexity of reducing such contaminants can be overwhelming. Moreover, controversy often develops when the "urban stream" turns out to be a fenced and concrete-lined stormwater channel. Flood control agencies argue that it is inappropriate to designate such conveyances for recreation and are now asking state and federal regulatory authorities to reconsider the recreational use classifications on stormwater channels.

Those in favor of deleting or downgrading a designated recreational use often point to fencing, steep-sided slopes, concrete-lining, and local ordinances prohibiting access to suggest that recreational activities are nearly impossible. Those who oppose changing the recreational use designation rebut such claims by citing the ingenuity and determination of people (especially children) drawn to the water, holes in the access barriers, the absence of patrols, and the lack of any serious enforcement effort to prevent trespassing.

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In order to resolve just such a dispute, stakeholders in the Santa Ana River watershed⁵ elected to forego the hypothetical debate and rely, instead, on empirical evidence provided by video surveillance cameras. Pictures provided by these cameras were used to justify a proposal to subcategorize recreational uses in some cases and eliminate recreational uses altogether in other cases.

APPROACH

Because all waters of the U.S. are presumed to be capable of supporting contact recreation, the burden-of-proof is always on those who believe otherwise with regard to any individual case. The most common complaint by those who initiate a UAA is that the process seems unfair because they are required to "prove the negative." How, they ask, does one ever demonstrate conclusively that full-contact recreational activity is NOT occurring?

Historically, proponents of reclassification have relied heavily on detailed descriptions of channel characteristics (e.g. slope, lining, fencing, low flow, etc.) to prove that recreational uses are unlikely to occur. Occasionally, these reports are supplemented with field surveys to determine whether there is any evidence of water contact recreation occurring (e.g. picnic trash, beach toys, etc.). However, such surveys are often criticized as little more than momentary "snapshots" of the stream in question.

The ability to state, confidently, that recreational activities are not occurring in a particular stream depends on how often one looks but finds nothing. Infrequent field surveys simply lack adequate sensitivity to detect relatively infrequent phenomena such as illicit water contact recreation. Therefore, methods of observation that offer greater statistical power are needed.

The same technology now in widespread use to provide traffic information was easily adapted to provide regular photographic surveillance of various waterbodies where the exact nature of recreational uses was in dispute. Several dozen prospective study sites were identified and nine locations, representing a wide spectrum of stream conditions, were selected for the initial investigation.

Some of the locations were concrete-lined flood control channels with 20-foot high vertical walls, others were more natural riparian areas with gentle side slopes. Some locations were fenced and posted, others were not. Some locations were in industrial or commercial areas, others were located in residential areas near schools or parks. Summertime flows usually varied from just a trickle to less than a foot in depth. However, peak winter flows could change these docile waters into raging torrents in very short order.

Wireless video cameras were installed in each location. The automated cameras were programmed to collect one image every 15 minutes (during daylight hours) for one year. Pictures were transmitted to a central server over a cellular internet connection. Technicians made weekly visits to service and maintain the equipment. Some of the problems encountered included: powering the cameras, assuring adequate cellular signal strength, and protecting

⁵ The Santa Ana River flows through three counties (San Bernardino, Riverside and Orange County) in southern California. It is located 40 miles southeast of the City of Los Angeles.

against vandalism. There were also some initial concerns with privacy rights. However, the images are insufficiently detailed to determine individual identities and the cameras were intentionally located in public areas where there is no expectation for privacy.

Pictures were evaluated, one at a time, by at least two trained personnel operating independently of one another. Each reviewer was required to identify the number of people in the channel, the number of people in the water, and the degree to which bodies were being exposed to water contact (e.g. ankle-deep, below the knee, wading to the waist, etc.). All of the pictures and related reviews were stored in a secure electronic database and copies were made available for public review on DVD.

Evaluating each of the individual pictures is a difficult and time-consuming task. Generally, the trained observer must flick back and forth between pictures looking for small changes to jump out of the frame. And, while it would be tempting to collect many more photos (real-time video can collect 30 frames per second), it be physically and financially impossible to analyze such a large mass of data.

The pictures are used to answer two questions: 1) are there any people seeking access to the waterbody, and 2) if so, what is the nature of their activities? Are they merely walking along the shoreline? Are they only making incidental water contact (e.g. walking thru water that is less than ankle-deep)? Or, are they making full-body contact where the risk of immersion and ingestion is quite high?

If definitive answers to these questions can be provided, then EPA guidance allows state regulators to adjust water quality standards based on site-specific differences in true risk exposure. This, in turn, can reduce the total cost of compliance by millions of dollars and allow finite public resources to focus on those stream locations where the potential threats to human health are greatest.

The remainder of this paper will focus on three of the locations where cameras were used, all located on different segments of the same stream (Santa Ana Delhi Channel), at one-two mile intervals.

RESULTS

The Santa Ana Delhi channel flows through a highly urbanized section of Costa Mesa in Orange County, California to Newport Bay and the Pacific Ocean. The channel characteristics vary widely along the route. Some reaches are concrete-lined vertically-walled flood control channels, other segments are significantly less modified. Fig. 1 illustrates these survey locations and depicts the physical characteristics of each unique segment of the Santa Ana Delhi channel. There are two red shaded segments on the map that indicate closed culvert sections, as the channel crosses under two major highways.

Fig. 1: Physical Characteristics for the Santa Ana Delhi Channel

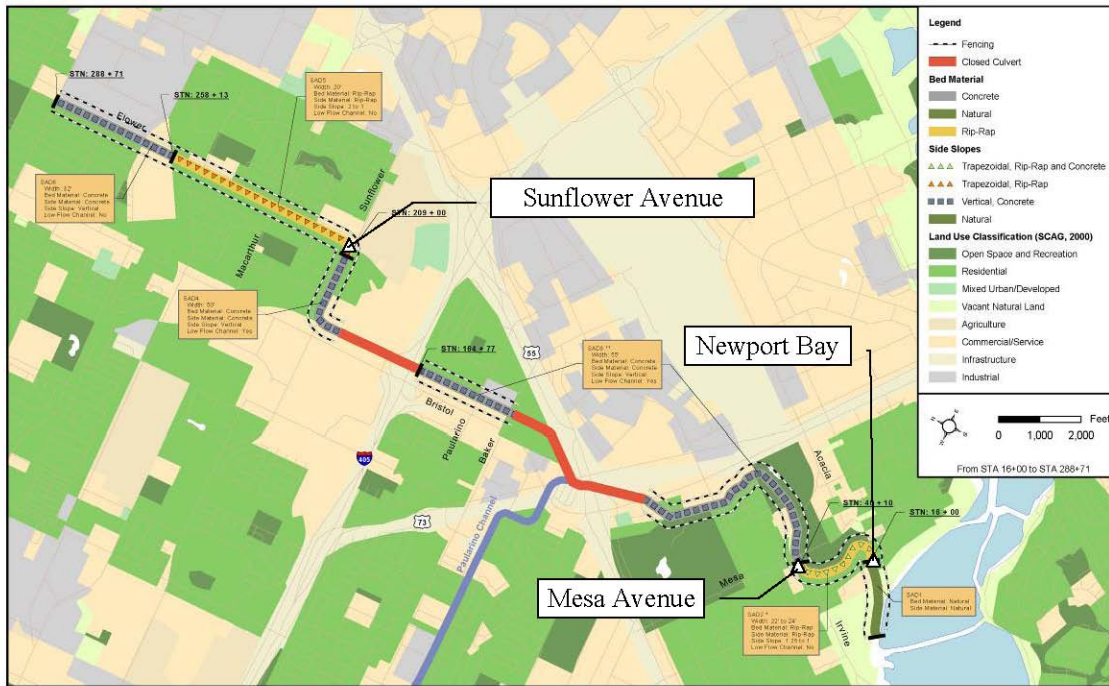


Figure 1

The first camera was located in a drainage channel in a residential neighborhood next to a schoolyard. Although the channel is fenced, it is relatively easy to circumvent this restriction. The rip-rapped side slopes are relatively mild and would not prevent a person from gaining access to the stream. Average stream flow is less than 1 cfs during dry weather conditions.

The second camera was located in a large concrete-lined flood control channel approximately one mile downstream from the first camera. The channel is characterized by 20-foot high vertical walls and is difficult to access without first scaling well-maintained chain link fences. The channel is adjacent to a golf course and park. Average stream flow during the warm weather months is less than two inches deep with significant amounts of algae present.

The third camera is located on a semi-natural earthen channel less than a mile downstream from the second camera where the Santa Ana Delhi channel empties into upper Newport Bay. The location adjoins a nature preserve where horse trails and walking paths allow people to be near the water but contact recreation is forbidden.

Table 1 describes the video surveillance period and the number of images collected at each of the three selected locations in the Santa Ana Delhi channel. A total of 63,332 pictures were taken during the one year UAA study period for this particular waterbody.

Table 1: Photographic Evidence Gathered at Santa Ana Delhi Channel

Site	Survey Location	Start Date	End Date	# of Images
#1	Sunflower Avenue	7/7/05	7/9/06	21,521
#2	Mesa Avenue	6/20/05	7/13/06	21,606
#3	Newport Bay	6/20/05	6/7/06	20,205

All contact recreational events (individuals) observed for each of the three survey locations along the Delhi channel including the date, maximum estimated duration and description of body contact are presented in Table 2. Infrequent observations of city or county workers carrying out channel maintenance activities were not considered contact "recreational" events).

Table 2: Recreational Water Contact Events in Santa Ana Delhi Channel

Location	Description	Date	Time	Est. Duration	Contact
Site #1	Sunflower Ave.	2/11/2006	14:45	<30 minutes	Below Ankle
Site #2	Mesa Ave.	No Water Contact Events Observed at Site #2			
Site #3	Newport Bay	7/24/2005	14:30	<30 minutes	Below Ankle
Site #3	Newport Bay	5/19/2006	12:30	<30 minutes	Below Ankle

Figure 2 shows a picture of the only recreational water contact event observed at Site #1 (near the schoolyard). Despite the fact that the child is actually standing on a stone in the middle of the creek, it is difficult to infer that full body contact recreation is likely to occur or that there is a serious risk of immersion or significant ingestion.

Fig. 2: Water Contact Recreation at Santa Ana Delhi Site #1



Table 3 summarizes non-contact types of recreational use for each of the survey locations. The total number of individuals recreating and estimated maximum duration of recreation is provided.

Table 3: Summary of Non-Contact Recreational Events in Santa Ana Delhi Channel

Location	# of Persons	Est. Duration	Activities
Site #1	6	180 minutes	Walking
Site #2	4	120 minutes	Walking
Site #3	36	1,110 minutes	Sitting, Boating, Walking

Figures 3 and 4 provide illustrations of typical non-contact recreational activities (e.g. walking) that occurs in shallow stormwater channels like the Santa Ana Delhi.

Fig. 3: Non-Contact Recreational Activity at Site #1



Fig. 4: Non-Contact Recreational Activity at Site #3



Figure 5 shows a picture of the concrete-lined flood control channel at Site #2. The person shown in the picture is a member of the study team and helps provide a sense of scale.

Fig. 5: Santa Ana Delhi Channel at Mesa Road in Orange County, California



All of the pictures in Figures 2 thru 5 are actual images collected and transmitted by the wireless video cameras installed for the UAA study. Figure 6 shows the camera installed at Site #1.

Fig. 6: Wireless Video Camera Mounted Under Bridge at Site #1 (Sunflower Ave.)



DISCUSSION

Of the more than 63,000 photographs taken, representing nearly 16,000 hours of potential recreational opportunities, only three pictures (<0.005%) show anyone actually being in a position to ingest water, even accidentally. In one instance, a boy is standing on stones as he crosses over the creek (see Fig. 2 above). In another, the person is crouching on the stream bank washing their hands after lunch (see Fig. 7) or illegally boating in the nature preserve (see Fig. 8).

Fig. 7: Water Contact Activities at Santa Ana Delhi Site #3



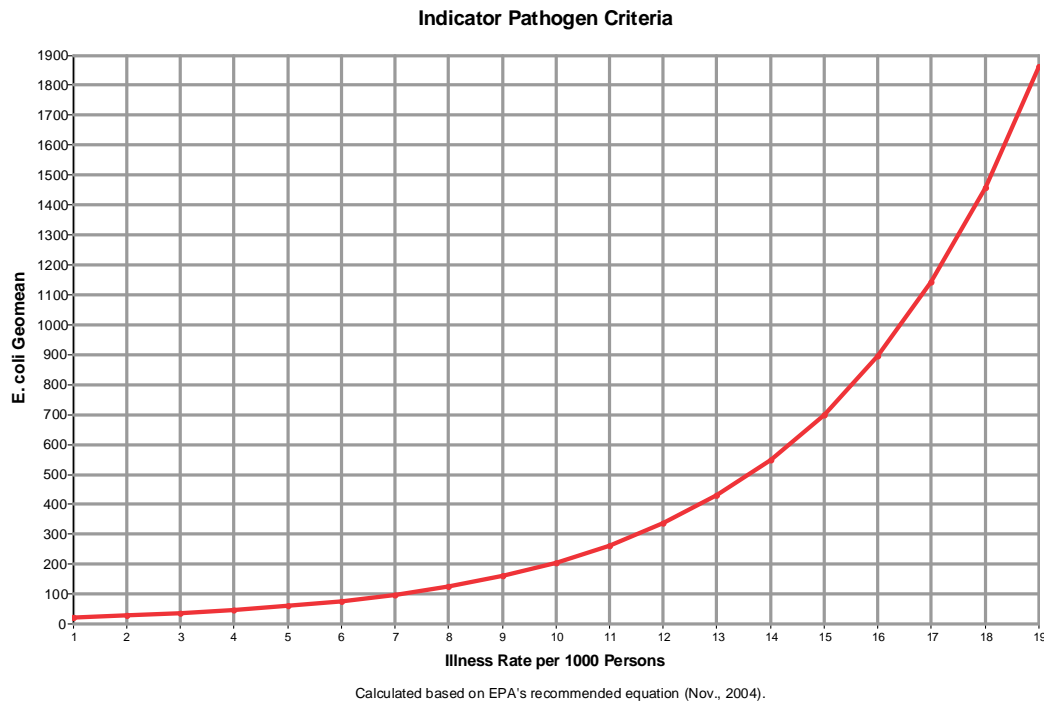
Fig. 8: Canoeing Activities at Santa Ana Delhi Site #3



In the studies EPA relied on to develop the 1986 recommended water quality criteria for bacteria, researches differentiated between those at risk of contacting a waterborne pathogen from those who were not by the length of exposure (>10 minutes) and the nature of contact ("wet hair"). Pictures like those shown above aptly illustrate that the prerequisite conditions for immersion and ingestion are unlikely to occur at the stream locations studied.

Moreover, even if each of the four people shown in Figures 2, 7 and 8 actually did fall in and ingest some water, the odds of contracting a gastrointestinal illness would still be quite remote. EPA's recommended water quality criteria for bacteria is based on the premise that approximately 1% of all persons exposed to the maximum allowable E. coli concentration are likely to become ill. If the actual E. coli concentration were ten times higher than the recommended criteria, then the expected illness rate would still be less than 2% of the exposed individuals (see Fig. 9). In a location such as the ocean beaches in Orange County, where people enjoy 30 million beach days annually, a 1% increase would result in tens of thousands of additional illnesses. However, in the stormwater channels where only a few people a year even come close to the water, it is unlikely that any illnesses are actually occurring.

Fig. 9: EPA Estimated Probability of GI Illness From Full Body Contact Recreation



EPA guidance makes clear that infrequent and incidental partial body contact, sometimes called Secondary Contact recreation, need not meet the same bacterial standards as Primary Contact recreation because the risk of immersion and ingestion is substantially lower. Pictures such as those developed with the wireless video cameras provide regulators and policymakers with substantial evidence to develop and apply risk-based water quality criteria without fear of endangering public health. Even representatives from environmental groups, who assisted with the development of the study design, site selection and picture evaluations, found the photographic evidence both surprising and reassuring.

IMPLEMENTATION

The first set of nine cameras produced well over 100,000 images. As with the pictures from the Santa Ana Delhi, photographs from the other locations showed very little water contact of any kind in the stormwater channels. Based on this evidence, it is likely that some or all of the nine locations will be reclassified.

For example, it is expected that in locations where people are present in the channel, but not actually immersing themselves in the water, the stream segments will be designated to protect Secondary Contact Recreation (infrequent, incidental, partial body contact). In locations, such as the fenced, high-walled, concrete-lined flood control channels, neither Primary Contact nor Secondary Contact are proposed to be designated uses.

Despite the consistency of the available photographic record, there is still insufficient evidence to generalize to all other similar flood control channel locations throughout the watershed. The plan is to observe and evaluate 10-20 additional sites over the next two years to develop very high levels of confidence in the dataset and in the conclusions derived from that data.

Thereafter, the cameras will continue to be used in locations and circumstances where the redesignation decision is particularly complex or controversial. In addition, as with any UAA reclassification, state regulators are required to review the subcategorization recommendation every three years to determine whether conditions have changed. Where the essential channel characteristics are unaltered, such a review can be relatively simple and straight-forward. However, where relevant factors (e.g. land use, stream flow) are changing with urbanized development, cameras may once again be needed to reconfirm some of the initial findings. As technology advances and broadband internet access becomes more readily available, the ease with which such cameras can be installed rapidly improves.

CONCLUSION

The greatest single benefit to using video cameras to evaluate the potential for recreational uses to occur in certain waterbodies is that it shifts the public policy debate away from hypothetical examples of how water contact might occur, to actually determining whether such contact is occurring. The persuasive power of 63,000+ photos showing nothing more serious than soggy sneakers simply cannot be overstated.

Ultimately, the purpose of this new tool is not to shirk responsibility for protecting public health. On the contrary, photographic evidence provides an invaluable tool for helping us decide exactly where we should focus our limited resources to gain the maximum benefit in risk reduction. If there are no people, or the people in the channels are not ingesting the water, then building infrastructure to reduce bacterial concentrations at those locations will not reduce the actual incidence of illness from waterborne pathogens. On the other hand, if the cameras show there are numerous people present, and that they are immersing themselves, then federal and state law requires water quality to be adequately protected even if the use itself is technically illegal.

The power of pictures to move the debate to a higher and more substantive level is enormous. While it is often said that "a picture is worth a thousand words," it is unlikely that any number of words could provide the level of regulatory certainty needed to justify reclassifying recreational uses. Only a picture, or several thousand pictures, can be so compelling.