EPA's Response To Comments on the Draft Class V Experimental Underground Injection Control Permit for the City of Los Angeles

As required by Title 40 of the Code of Federal Regulations (CFR), Part 124.17(a), the United States Environmental Protection Agency, Region 9 (EPA) shall briefly describe and respond to all significant comments on the City of Los Angeles' draft Class V Experimental Underground Injection Control (UIC) permit raised during the public comment period. What follows is EPA's response to the comments received.

In summary, EPA determined that only one minor change to the draft permit is necessary in response to comments received. The specific change, which is fully explained in the Response to Comment 8 below, involves a clarification to the Construction Plans and Schematics in Appendix A that the casing strings will be "cemented to surface." EPA made no other changes to the permit language. The final decision to approve the permit is based on EPA's determination that all activities allowed under the permit will be in compliance with the Safe Drinking Water Act's UIC Program regulations.

I. Response to Significant and Applicable Comments

Comment 1 : *Several commenters stated that alternatives to underground injection have not been considered and need to be considered. They suggested that alternatives for biosolids disposal already exist and that the proposed project is a wasteful expenditure of energy. In addition, they suggest that EPA should evaluate the full life-cycle costs and benefits and discuss each alternative disposal method in comparison to this underground injection project.*

Response: The U.S. Environmental Protection Agency (EPA) does not have the authority under the Safe Drinking Water Act's (SDWA) Underground Injection Control (UIC) program to require a specific treatment and disposal procedure. Nor does the SDWA or the UIC regulations require project proponents to demonstrate the cost-benefit feasibility of their proposed activities. Rather, the UIC program's role is limited to evaluating whether or not proposed underground injection activities are in compliance with the Act and other federal statutes. EPA has determined that the injection activities allowed under the City of Los Angeles' permit will not impact underground sources of drinking water, and comply with all requirements of the Safe Drinking Water Act.

Comment 2: *Commenters stated that the draft permit does not contain information on the range of biosolids particle sizes and that the permit does not discuss core sample analyses to establish whether the target sandstone (the injection zone) will be permeable to the biosolids particulate. They expressed concern that plugging of the injection zone (by the plating off of biosolids particulate matter) will result in an injection pressure that will exceed the fracture pressure of the injection zone formation.*

Response: The commenters are correct that this project involves injection at pressures that will exceed the parting pressure, the pressure at which fractures will form in the injection zone. Whereas underground injection practices more typically involve injection pressures below a level which will cause fractures to form, this experimental project does allow controlled hydraulic fracturing to occur.

Since controlled hydraulic fracturing is authorized, the permit does not limit particulate size in the biosolids slurry (nor require an analysis of the range of sizes), except for screen/sieve removal of the large solid pieces that cannot be practically mixed into a slurry capable of being pumped by the operator's equipment. While a successful core sampling and analysis is a requirement of this permit, it is not the purpose of the analysis to examine whether the biosolids particulate matter can flow through the interconnected pore spaces of the injection zone. Typically, pore spaces in sandstone formations become plugged with extremely small particle-sized matter unless those particles are removed from the injectate stream. However, in this project, the slurrified mixture will purposefully bypass the interconnected pore spaces by means of hydraulically created fractures which will serve as temporary conduits for the slurry to flow. These hydraulic fracture conduits are temporary only for the duration of the active pumping of the slurry, typically 8 hours daily. Once pumping is ceased, the fractures will close back upon themselves as the liquid phase of the slurry is allowed to seep through the fracture walls causing the pressures to dissipate into the larger injection zone formation. The solid portion of the slurry remains entombed within that narrow space where the fracture was previously held open under pressure.

Comment 3: *One commenter stated that the biosolids mixture from the treatment plants listed in the draft permit contain a wide variety of chemicals (heavy metals, solvents, etc.) and will be more highly contaminated compared to sludge from a typical municipal wastewater treatment plant. They suggest bench scale testing should be carried out, using the more highly contaminated sludge, to carefully test the fate of such industrial chemicals as well as pathogens, and the ability to biodegrade under conditions similar to those expected to occur in the subsurface. The commenter also expressed concern that the City of Los Angeles will not be able to recover the mass of biosolids injected.*

Response: Bench scale testing has been conducted and evaluated at surface conditions (temperature and salinity) and at in-situ conditions of pressure, temperature and salinity. Additionally, separate and independent literature research efforts were conducted to address this matter. Both the testing and the literature search strongly suggest that in time, all organic compounds will eventually be reduced to inorganic constituents either from surface-introduced microbes or from native microbes.

The biosolids that are permitted for injection have undergone, and will continue to undergo, testing and analysis to identify their constituents. The biosolids are classified as a non-hazardous mixture. The biosolids that will be used for creation of the slurry are presently approved for land application under 40 CFR Part 503.

As stated in the Response to Comment 2 above, both the biosolids and the liquid medium that make up the slurrified injectate are to be permanently entombed within the injection zone. The permit stipulates that excursions from the injection zone are prohibited. The permit also has requirements that allow for early detection of potential excursions, such as tubing leaks or ruptures from the authorized injection zone, far in advance of contamination of any underground sources of drinking water (USDWs). The permit, therefore, requires that the slurry injectate and any products of biodegradation be permanently contained within the injection zone. Recovery of the bioslurry (slurrified solids, liquids) is therefore neither planned nor possible. However, recovery of any methane generated (a main objective of the experimental objective exploring subsurface methane creation as a by-product of the biodegradation of the biosolids) is a planned component of the City's project.

Comment 4: *Some commenters questioned EPA's classification of this project as Class V experimental since fracture injection, methane generation from biosolids, and some aspects of geological carbon sequestration have been implemented before. They further noted that after the technology is demonstrated, the well(s) in question would revert to classification as Class I Municipal wells which, under the UIC regulations, would be limited to an injection pressure that is below fracture pressure. One commenter asserts that the methane production is just a smoke screen to get around the existing Class I regulations and that the overriding purpose of the project is simply to dispose of unwanted sludge. Others also questioned whether methane would be generated at all, given the high pressures at injection depth, and noted that even if generated, the gas would be diffused and not economically viable to extract in commercial quantities.*

Response: A project that involves the combination of fracture injection, methane generation from biosolids, and geological carbon sequestration has never been attempted. The EPA deemed this project Class V Experimental for reasons that include methane generation and carbon sequestration, and for the combination of accomplishing these using fracture technology, while acknowledging that fracture technology in itself is considered a mature technology. Other reasons for the classification of Class V Experimental include quantifying in-situ, post-generated methane and carbon dioxide fate and behavior, mathematical algorithm development for increased accuracy of locating fracture tip propagation and location, identification and assessment of microbes involved in biodegradation, and the separate goals of independent research from at least three universities. EPA has determined that this project will be protective of USDWs and public health, and we believe it will advance current knowledge and understanding of the deep biosphere.

While injection of municipal waste would ordinarily be regulated by EPA as a Class I UIC operation, here, there are additional technologies, outlined above, being considered which make classification of this project under Class V appropriate. EPA regulations make clear that "experimental technology" is "a technology which has not been proven feasible *under the conditions in which it is being tested*." 40 CFR 146.03 (emphasis added). Guidance issued by EPA also makes it clear that some Class V experimental wells would "otherwise fall under another well classification." Appropriate

Classification and Regulatory Treatment of Experimental Technologies. Ground-Water Program Guidance No. 28, Victor Kimm, Director, Office of Drinking Water, May 31, 1983 ("Guidance 28").

Guidance 28 states that "[i]n view of the different types of experimental technologies that may exist, the Agency has determined . . . that the appropriate interpretation is that some technologies will be considered to revert to their original class when the technology becomes commercially feasible, while others will remain in Class V pending any future regulation." Guidance 28 at 2. Therefore, it is premature to determine what will happen upon permit expiration.

The concern that the experimental technological application regarding methane generation may be ineffective is not, in EPA's consideration, a reason to deny the City's proposed project. As noted above, EPA's responsibility under the SDWA's UIC program is to ensure that subsurface injection will not endanger USDWs or public health. Should the experimental project not accomplish the results of methane generation and extraction anticipated by the City, EPA believes the project will still comply with the Act and with all permit requirements. EPA's classification of this project as Class V Experimental represents an acknowledgement that the technological application "has not been proven feasible under the conditions" being tested. Yet, the Agency has determined that the proposed experimental project can proceed in a manner that will be protective of USDWs, even if certain aspects of the experiment ultimately do not "succeed" as envisioned.

Comment 5: *Some commenters expressed concern that the proposed injection of municipal biosolids into a deep well may cause earthquake disasters. A commenter predicts that micro-seismic events will occur with a chance that larger scale events may be induced. Another commenter stated that the permit's requirements to perform seismic monitoring may not be sufficient to provide adequate warning and suggests at least 7 to 12 monitoring stations are needed to establish a seismic monitoring baseline before the commencement of injection operations. Finally, a commenter is concerned that the draft permit does not adequately consider nor mitigate risks of ground shaking (from natural earthquakes) that will cause rupture or failure of the permitted wells resulting in leakage.*

Response: Although the project area is located in a seismically active region, EPA believes that the City's proposed biosolids injection will not cause seismic events that can be felt by humans at the surface, much less causing "earthquake disasters" as the commenters expressed. The proposed injection zone is a sandstone formation that is well characterized in the project area (i.e., the Wilmington Oilfield), and is described geologically as an "unconsolidated sandstone." This type of unconsolidated sandstone, which is located at an approximate depth of 5,000 feet below ground surface, is relatively soft compared to the deeper basement rocks where natural earthquakes typically originate. According to data from U.S. Geological Survey seismic monitors, earthquakes in the project area have been located at depths in the range of 30,000 to 60,000 feet below ground surface, which is well below the City's target injection zone. Also, slurry fracture

injection has been conducted for over 11 years at the nearby THUMS platform with no earthquake activity attributed to it.

The "hydrofracturing" action of this project has been likened to a "dilation" of the injection zone sandstone into "fracture-like geometries." This is advantageous over the more easily detectable, audible cracking and snapping of the much deeper, harder rock formations mentioned earlier because this will not be felt by humans at the surface. Furthermore, it is technically difficult to detect the sounds of these dilations of the soft rock with even the best available borehole geophones (geophone arrays installed deep within the monitoring wells - boreholes - of this project) located within very close proximity to the project area.

In terms of monitoring, the permit requires continuous pressure and temperature monitoring, radioactive tracer logging, and tiltmeter monitoring. The data collected from these monitors will confirm fracture location and characteristics (height, azimuth and containment), and confirm containment of the injectate within the target formation. Although additional monitoring stations would obviously provide more data, EPA is confident that the proposed monitoring regime is adequate to assure compliance with all applicable requirements in the permit, and to detect any seismic activity within the project area.

As an added safety feature, the permit also requires the City to install a sophisticated borehole geophone monitoring system that will provide data on the fractures within the targeted sandstone formation and surrounding micro-seismic activity. These monitors will provide continuous data that the City is required to use to locate and track the fracture tips as they propagate outward from the wellbore while being contained within the injection zone.

As for the concern that naturally occurring seismic activity in the region could damage the injection well and result in leakage, EPA believes that the extensive history of successful deep well activity in this area suggests such a scenario will not occur. There currently exist approximately 7,000 deep wells in the immediate area surrounding Terminal Island. Many of these wells**,** especially those within the Wilmington Oilfield, already penetrate the same sand and shale formations as those that will be impacted by the wells associated with this project. Historical evidence shows no significant damage to this vast number of oil and gas wells in the area from major earthquake activity. Similar to that of the oil and gas wells, the design of the wells in this project is more than adequate to withstand the strain waves generated by a naturally occurring major earthquake. Moreover, the design of the wells will be more resistant to such potential damage than the typical design of most of the oil and gas wells in the state of California because of the monitoring and cementing requirements imposed by EPA's permit.

Comment 6: *One commenter expressed concern that EPA's proposed permit does not require an adequate network of tightly spaced monitoring wells to track transport of the injected biosolids and the formation and migration of degradation products. The monitoring system should be able to track flow through permeable and fractured*

formations, as well as other flow paths, such as abandoned wells. Without adequate monitoring, improperly plugged and abandoned wells in the area may serve as unintended conduits.

Response: The Agency agrees that tracking the movement of the injectate and biodegradation products, to ensure the protection of USDWs, is an important aspect of this project. Likewise, monitoring changes in formation pressure is critical to ensuring that abandoned wells in the vicinity of the project area do not become unintended conduits to the surface or to shallow formations. To address these issues, the permit requires an extensive array of monitoring. First, as noted above, the permit's requirements for temperature logging and the use of low-level radioactive tracers will help to monitor the flow of injected material. The permit also requires two dedicated monitoring wells to be located "updip" of the injection well (i.e., at a stratigraphically higher location) and within the injection zone. These wells will be located beyond the extent of the fracture tip locations. The monitoring devices and other equipment in these wells will accurately measure the pressure within the injection formation and will capture samples of the formation fluids which are expected to contain, at a minimum, quantifiable evidence of the biodegradation products (methane, carbon dioxide, etc.) resulting from microbial action within the injection formation.

As noted in the permit, there are three abandoned wells about 1 mile from the proposed injection location. Neither the injection fluids, nor their biodegradation byproducts, are expected to ever reach these three abandoned wells. However, pressure increases within the injection zone could potentially be realized at these locations if any or all of the three abandoned wells coexist within the same reservoir - or pressure system of the injection zone that is penetrated by the injection well. The permit, therefore, places limits on the amount to which pressure may be elevated at the location of the injection well (the location where the highest injection pressures will occur within the injection zone). In addition, the permit requires the City to monitor the pressures at the injection well and the two monitoring wells, and to extrapolate from these data (using a sophisticated and technically justified mathematical technique) the pressure response at the locations of the three abandoned wells.

Comment 7: *A commenter expressed concerns about the strength and durability of the injection well, and the performance of the annular seals. In addition, the commenter does not believe that the pressure testing required by the permit is refined to the extent needed to detect slow, sustained leaks, especially in upper geological zones.*

Response: EPA agrees that these issues, which pertain to the mechanical integrity of the wells, are extremely important for the proper operation of injection wells and to ensure protection of USDWs. The mechanical integrity requirements of the UIC program, which EPA incorporated into the City's permit, are designed to provide numerous and complementary levels of protection. The UIC program also addresses two types of injection well mechanical integrity – internal and external – both of which are further described below.

"Internal" mechanical integrity refers to the inside of the well - the tubing, packer, casing, and well head. The principal means of demonstrating that a well has internal mechanical integrity, and detecting a potential loss of mechanical integrity, is pressure testing and monitoring. The pressure testing requirement, which is contained in the City's permit, involves an annual pressure test, whereby maximum allowable pressure is applied to the annular space between the tubing and the long string casing for 30 minutes. The well passes this test (i.e., demonstrates internal mechanical integrity) when there is less than a 5 percent change in the pressure over the 30-minute period. The sensitivity of this test is adequate to detect extremely small leaks which are related to loss of internal mechanical integrity. Moreover, any small leaks detected during pressure tests or from monitoring during normal operations typically do not indicate that contamination has occurred, but rather serve as an indicator of potential fluid movement which the operator is required to address. Remediation of any detected leak is required, following immediate cessation of injection activities. Further requirements such as corrosion inhibited annular fluids add to the permit's level of safety and assurance of well integrity.

"External" mechanical integrity refers to the outside of the casing strings of the wells, including the cement that is grouted into the annular space between the casing and the drilled hole. The wells are evaluated for external mechanical integrity initially upon construction, and also periodically throughout the project. The external integrity of the wells is addressed by employing diagnostic tools designed to verify that neither extremely small leaks (flows through vertical channels between the casing and hole) nor extremely small spaces or gaps in the cement bonding to the casing or to the drilled hole exist (because those gaps may accommodate leaks or flows at a later time during the project). The tools used in this effort include cement evaluation, radioactive tracer, and temperature logging tools and a permanently installed fiber optic temperature tool in the injection well.

The City's permit further requires mechanical integrity of the confining zones through pressure monitoring, logging with various downhole diagnostic tools, tiltmeter and borehole geophone monitoring and through requirements and documentation at the time of construction. A loss of integrity of the permit's initial confining zone would be made evident through the monitoring and analysis of the above mentioned requirements.

Note that the permit makes it clear that numerous confining zones and injection zones exist within the total permitted injection interval and that these may be sequentially authorized for injection/confinement later, if necessary, though this is not expected to occur within the 5-year life of the demonstration project. Therefore it is an additional safety feature of the permit that an overlying confining zone would contain any leaks (injection) from the lower, currently authorized confining zone.

Comment 8: *A commenter was concerned that the number of sacks of cement indicated in the permit is not sufficient to complete the surface and long string casings. The commenter also expressed concerns that the long string casing needs to be cemented in two stages.*

Response: While the Appendix A Construction Schematics were not intended to display the complete drilling program in detail, we acknowledge that the number of sacks of cement are short of what the expected requirement will be at the time of construction (depending, for example, upon actual dimensions of the drilled hole). We also agree with the commenter that the long string casing will probably be cemented in two stages. Since it is not possible to predict exactly how many sacks of cement will be required until the exact dimensions of the final drilled holes are measured, the Construction Plans and Schematics of the permit will be changed to specify the requirement that the casing strings are "cemented to surface."

Comment 9: *One commenter noted that, as provided in the California Water Code, Waste Discharge Requirements (WDRs) must be obtained before a discharger can discharge wastes to a water of the state (including subsurface disposal on land, which may impact ground water). The commenter is concerned that in addition to federal and state regulations, local agencies may have concerns and local requirements that apply. The commenter also expressed concern that impacts have not been disclosed in a manner that meets requirements in the California Environmental Quality Act (CEQA).*

Response: A UIC permit issued by the EPA does not authorize any infringement of State or local law or regulations, nor does it convey property rights of any sort or any exclusive privilege, nor does it authorize any injury to persons or property, or any invasion of other private rights. In short, issuance of a UIC permit does not relieve the permittee of any duties or requirements under all applicable laws and regulations, federal, state or local, including those cited by the commenter. A permittee is still required to get any permits or authorizations required by state or local law.

In addition, CEQA is a state requirement and thus, compliance with CEQA is not required in issuing this federal permit.

In this matter, EPA has been and remains mindful of the interest of state agencies. We have shared data and information with state agencies since the inception of the City's proposal, and we will continue this coordination and data sharing throughout the life of the project.

Comment 10: *One commenter noted that both the federal government and the State of California have well established programs for the handling, treatment, and disposal/recycling of sludge. These programs are implemented pursuant to EPA's regulations at 40 CFR Part 503 and the State's Water Quality Order No. 2004-0012 DWQ- General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities (General Order). The commenter questions whether permitting the discharge of biosolids through another program - namely, the EPA's UIC Program – will afford the same level of public health and environmental protection as these well-established programs.*

Response: 40 CFR Part 503 is not applicable to the proposed activity. Section 405(e) of the Clean Water Act states that "the determination of the manner of disposal or use of sludge is a local determination" except where EPA has established regulations for such disposal pursuant to section 405(d). Where such regulations have been promulgated, disposal must be "in accordance with such regulations." EPA has promulgated regulations regarding the disposal of sludge at 40 CFR Part 503 for "sewage sludge applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator." 40 CFR section 503.1(b)(2). Because Part 503 does not regulate the disposal of sewage sludge by injection, the manner of disposal is a local determination. However, because the sewage sludge is being injected, this activity is regulated by the EPA under the Safe Drinking Water Act, Underground Injection Control program.

The US EPA's UIC program is specifically designed to authorize injection of material into the subsurface in a manner that protects USDWs. Injection of municipal wastes has historically been regulated by the UIC program, though the waste stream is typically liquid. This permit authorizes injection of municipal biosolids that have been made into a "slurry" which will behave essentially like a liquid. The slurry has been classified as a RCRA non-hazardous material, and the permit requires that any injectate continues to meet that classification. The permit authorizes the City of Los Angeles to inject the biosolids slurry into an underground sandstone which is a 20,000 ppm TDS saline aquifer. This non-potable aquifer is located well below the lowermost USDW and is not afforded protection by state or federal regulations (the State of California protects USDWs containing 3,000 ppm TDS or less and the federal level of protection is 10,000 ppm TDS or less). This UIC permit, as do all such deep-well UIC permits, regulates the operational emplacement of the injected material into the saline aquifer in a manner that is protective of the overlying USDWs, human health, and the environment. It is noteworthy that the biosolids that will be used for creation of the slurry are presently approved for land application under Part 503.

Regarding the commenter's assertion about the State's Water Quality Order No. 2004-0012, we refer to our response to Comment 9 above, which notes that issuance of a UIC permit by EPA does not relieve the permittee of any duties or requirements under all applicable laws and regulations.

Comment 11: Several commenters expressed support for the proposed injection project. One noted that the current methods of disposal of municipal biosolids are not sustainable and it is therefore critical for California sanitation agencies to study and evaluate alternative solutions such as deep injection. Another commenter noted the long track record of deep well injection in water desalinization projects and in the oil and gas industries as evidence of the potential success of this project. A commenter shared their view that L.A. is in the best position to determine how to manage its biosolids, and also suggested that EPA Region 9's rigorous literature and data review demonstrates the overall safety and effectiveness of the injection well technology.

Response: No response required.